YOUR CONSTRUCTION AND OPERATING QRP SOURCEBOOK

# QRP Quarterly

Volume 50 Number 3
Summer 2009
$4.95

Journal of the QRP Amateur Radio Club International




- FDIM 2009 Highlights (Were You There?)
- WA6LTV Reviews the Genesis G40 SDR Kit
- Antennas 101: A Simple Circuit Makes Test Signals for Your R-X Bridge
- WD3P's Story of the First All-QRP CW USA-CA Award
- Contest Results—
  2009 Grid Square Sprint
  2009 ARCI Spring QSO Party

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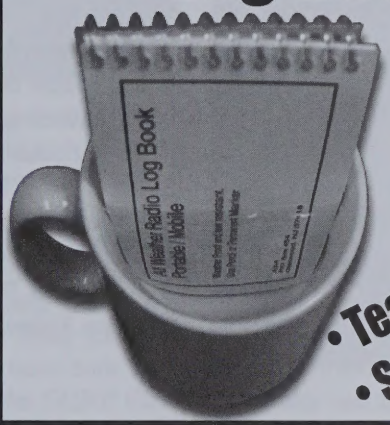


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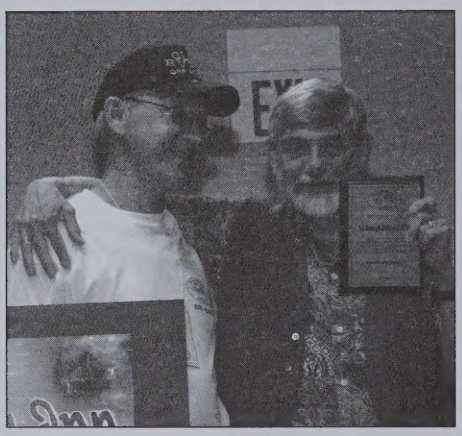
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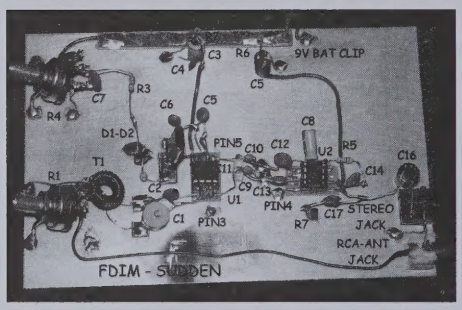
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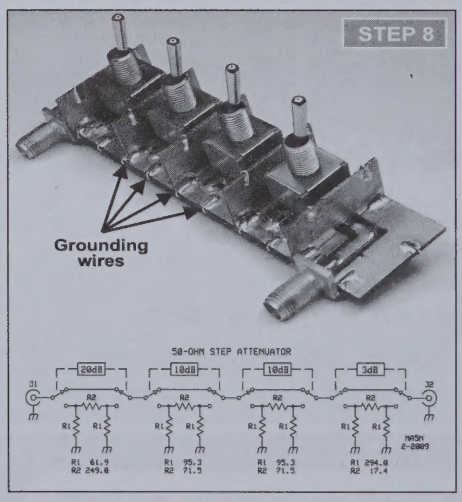
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**QRP QUARTERLY EDITORIAL STAFF**

Editor
**Position vacant**

Associate Editor & Idea Exchange
**Mike Czuhajewski—WA8MCQ**
7945 Citadel Dr.
Severn, MD 21144-1566
**wa8mcq@verizon.net**

Associate Editor
**John King—KB3WK**
9936 Whitworth Way
Ellicott City, MD 21042
**kb3wk@arrl.net**

Associate Editor
**Dennis Markell—N1IMW**
47 Old Farm Rd.
Bedford, NH 03110
**dennis_m_markell@uhc.com**

Associate Editor—Contests
**Jeff Hetherington—VA3JFF**
139 Elizabeth St. W.
Welland, Ontario L3C 4M3, Canada
**contest@qrparci.org**

Production & Advertising
**Gary Breed—K9AY, and staff**
Summit Technical Media
104 S. Grove Street
Mount Horeb, WI 53572
**gary@summittechmedia.com**

**REGULAR COLUMNISTS**

QRP World News
**Oleg Borodin—RV3GM**
**rv3gm@qrp.ru**

VHF QRP
**Bob Witte—KØNR**
**bob@k0nr.com**

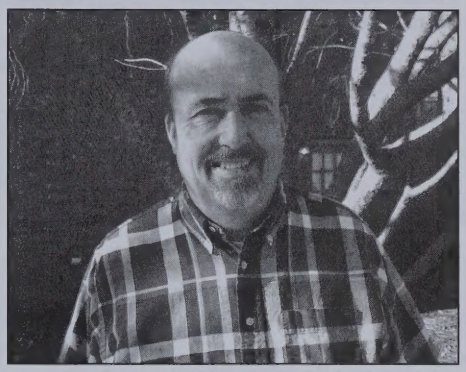
QRP Clubhouse
**Tim Stabler—WB9NLZ**
**wb9nlz@yahoo.com**

QRP ARCI Awards
**Jay Bromley—W5JAY**
**awards@qrparci.org**

Antennas 101
**Gary Breed—K9AY**
**k9ay@k9ay.com**

# From the President

Ken Evans—W4DU president@qrparci.org



There is an old saying that all good things must come to an end. So it is with the tenure of Dick Pascoe, GØBPS as president of QRP ARCI. It has been my privilege to serve as the club's vice president with Dick over the past five years. These past years have seen the club's active membership move from 1,800 to approximately 2,400. We have built very close relationships with the GQRP Club that helped provide assistance to hams in other countries. The QRP ARCI presence at ham fests has increased, and as a result, more people are aware of and involved in QRP. FDIM has consistently improved each year and has become world renown as a premier QRP event. Over the next three years, I will endeavor as your president to continue to move the image of QRP as a positive force in amateur radio. I offer my thanks to Dick for a job extremely well done. You will be missed.

Some of you have seen me at various events, but may not know my background. I hold an extra class license and have been a ham since 1961. I am an "elder" member of QRP ARCI (member number 696) having joined the club in 1964. I was absent from amateur radio from 1967 until 1980 due to military service (U.S. Army) and marriage/children. I returned in 1981 and have been active since. Currently, I am semi-retired; I have been married for 41 years and have four adult children and twelve grandchildren. My current interests in QRP are homebrewing and 160/80 meter DX, although I am known to hang out around 7030 and 50.095 CW.

When Dick informed me that the board of directors had elected me to the presidency (effective July 1, 2009), he also told me that they wanted a recommendation from me as to whom I would recommend to serve as vice president. I am pleased to inform you that the board elected Kathy Bromley, WQ5T, to serve as your vice president for the next three years. Kathy lives in Ft. Smith, AR, with her husband, Jay, W5JAY. She holds an extra class license and has worked a bit of DX on 20 meters. Kathy is a tireless worker that has helped immensely with the past three FDIM events. She brings excellent administrative skills to the office that will be used to help with budgetary, financial and organizational issues as we move the club forward. She will be a great deal of help to me and an asset to the club over the next three years.

Did you make it to FDIM this year? It was a great time with excellent speakers at the Thursday Seminar; great products from the vendors and as usual, a number of very well made and interesting projects at the hombrew display. The buildathon was a huge success this year with a focus on manhattan construction. Thirty-two participants built a simple 40-meter receiver. You'll find more information on both FDIM and the buildathon in this issue. Start planning now for next year. At the awards banquet on Saturday night there were four well-deserving hams inducted into the QRP Hall of Fame. They are: Rick Campbell, KK7B; Martin Jue, K5FLU; Tony Parks, KB9YIG; and Hans Summers, GØUPL. Most of us know of the accomplishments of our American counterparts. However, Hans Summers may be a new name in North America. For the benefit of USA members, his QRP exploits are enumerated in this issue by Tony Fishpool.

At my local QRP club one of the members stated that he had done something novel recently. He got on the air and made several contacts! I took it as an attempt at humor, but realized that I hadn't been on the air in a month. I was so involved in FDIM activities I simply didn't turn on the rig and enjoy the hobby. Sometimes we need a challenge. Our Publicity Manager, Jim Stafford, W4QO, has developed the Worked All ARCI Challenge. It is an on the air activity that will

(*continued on next page*)

encourage us to get on the air and work each other. Details are in this issue.

I look forward to working to serve the club over the next three years. Many have told me that QRP rejuvenated their interest in ham radio. We have a unique niche in the hobby where we can use a small simple approach to maximize our enjoyment and feelings of accomplishment. With many new hams coming into the hobby, we have an opportunity to invite them to join us in our QRP adventures. The newer hams will bring their enthusiasm and interest in some of the newer technologies in the hobby. One perception that needs some work is that QRP is an HF CW activity. For a great many of us this might be true. However there are many modes that we can explore. We cannot nor should we abandon our roots in HF CW. But we should consider expanding our focus to include newer modes and VHF. As we move forward, we are interested in your thoughts on further advancing QRP's role in amateur radio.

*72, Ken, W4DU*
*QRP Future*

●●

# QRP News



**Farewell to a Friend**
**Mary Cherry, NA6E, 1957-2009**

It is with great sadness that I write this. Mary lost her battle with cancer on June 15th, 2009, while at home with her loving husband, Mark, WT6P. During her long and painful battle she did not want many people to know about it. She did not want people feeling sorry for her!

Mary was well known in the hobby. She was a past editor of the *QRP Quarterly.* Mary was a very good CW operator who liked getting into many contests where she usually did well. She also had fun in some SSB contests where a YL voice was worth a good 6 dB! She may be best known in the contest world for her RTTY efforts. She has won many certificates, something that most of us have a hard time doing! She had a nice tower and Yagi, and she was the one who did the climbing and there are even pictures proving that. She was a Chief Petty Officer in the U.S. Navy, working in the field of cryptography while in Spain.

I have one story to tell. The first time I met Mary was when I picked her up at their home in Sacramento, CA. From there we went to Pacificon where Chuck Adams, then K5FO, and I were doing a little CW contesting presentation. As Mary and I pulled into the parking lot of the motel, Chuck was walking down the sidewalk. We got out and Chuck said "Hi" to me and then went to Mary and said "Hi Carol, (my XYLs name is Carol) nice to meet you." I looked at Chuck and said, with a straight face, "That's not Carol." Mary knew just how to act and looked like a kid who got caught with her hand in the cookie jar! Chuck was mortified! It wasn't until later that evening that we told him the truth! Mark arrived the next evening after he got off work and got a big kick out of it! Mary, Mark and I have laughed about that for all these years!

Mary, NA6E, is survived by her mother, Dorothy, her brother, Michael, and her husband, Mark, WT6P. She was a wonderful, happy, positive young lady who will be missed by all. 73 & 88 from us all.

*Ron, KU7Y*

**Worked All ARCI Challenge—August 1 to December 31, 2009**

In the early days of QRP ARCI, the *QRP Quarterly* (at that time just a few mimeographed sheets) was taken up with pages full of members and how many others with whom they had traded QRP ARCI numbers. Does this sound familiar? Today we have FISTS, SKCC, and NAQCC clubs all trading numbers, and to their credit it has provided many of us with a purpose for a QSO and hours of fun. Yet today when I ask for an ARCI number on the QRP frequencies, I am often met with "I don't remember my number." Once you have your number, it is available for you to use whether you are a current subscriber to *QQ* or not (however, we hope you are a subscriber). Also, you may find your number on the www.QRPARCI.org website by entering your callsign.

In a related vein, your club has offered for years the Worked All ARCI award. The award is available for working 50, 100, 200, 400, 800, and 1600 ARCI members. Now IF you had to collect the associated QSLs to get the award it would be a very large task indeed. But a couple of years ago, ARCI decided to offer their awards using the GCR (General Class Review) method of authentication. This means that 2 General Class operators need to go over your log and certify the validity for the award being applied for. We highly encourage you to think in terms of achieving the Worked All ARCI Award.

But here is a new challenge with some great prizes. During the next 5 months beginning August 1, the person who collects the most QRP ARCI numbers will be recognized as the FIRST place winner of the Worked All ARCI Challenge and will be awarded a gift certificate for $100 worth of Elecraft products! Second place will receive a $50 gift certificate to MFJ, and the 3rd place entrant will receive a one-year extension to their QRP ARCI membership. Of course, nonmembers may also collect numbers, but it seems that having a number to trade would make sense. So if you are reading this and are not a member, why not go ahead and join? The rules are simple. Trade as many numbers as you can during QSOs or contests using 5 watts CW/Data or less (10 watts PEP SSB) as your transmitted power. Keep track of your results on a "log type spread-

sheet" showing Date, Time, Callsign, Band, and QRP ARCI number. Before January 31, 2010, submit your log either by e-mail or handwritten (GCR please) to W4QO@qrparci.org or to my callbook address. Winners will be subsequently announced.

Get started on all the QRP frequencies. Remember there are a number of QRP ARCI contests in the second half of the year, a great place to pick up numbers. Who will win the First QRP ARCI Challenge?

*Jim Stafford, W4QO*

●●

# QRP Awards

Jay Bromley—W5JAY awards@qrparci.org

Before I get to talking about the QRP ARCI Awards program, let me introduce myself or re-introduce myself. My name is Jay Bromley and I hold the call of W5JAY. I am also one of your QRP ARCI directors. Right now my main interests are QRP, antennas, contesting, DXing, and digital modes. In the past I was heavily involved with audio and modes such as AM, however these have taken a back seat to my current interests, but I still have a love for them.

I also chase awards, and I have gone after a few of the QRP ARCI QRP awards. I am currently applying for ARRL's 5BDXCC. I have DXCC on 160m which I am very proud of. No I didn't do it QRP, but I think it is possible with the right antenna and location. I am sure someone will conquer this some day! I managed to do it from a small city lot with compromised antennas. They say the harder the award the more fun it is, I can relate to that with the 160m DXCC. This year, thanks to Bill Kelsey I went after ARRL's Triple Play Award and finally made it, number 232!

You would think I would be flying the QRP ARCI flag here instead of the ARRL's, but I want you to know I understand what it is like to go after an award. I tend to be a big cheerleader for QRPers chasing a QRP ARCI award. I think it is important to have other interests in the hobby so we can pull more folks into our side of the hobby. How can you do that if you are not trying everything in sight?

I also do a fair amount of Elmering and hope you do to. In my spare time, I am usually helping guys get set up on digital, LoTW or programs such as HRD, MMTTY, MixW, DXlab, etc., learn CW, and of course QRP. Many times the ones I Elmer today come back and Elmer me tomorrow! Now I have a new way to Elmer, by telling everyone to try for a QRP award. Trust me this is fun stuff and for some awards the wait is minimal.

I hope this doesn't sadden anyone, but I am not what I would call a great QRPer. I don't live for the mode, but I do love it and the people involved, but I am not one of those guys that have a 1 watt homebrew rig and wire antenna that I make all my contacts from. However I do admire the ones I call "Real QRPers." I am pretty diverse or try to be when it comes to ham radio.

So how in the heck did a person like this get to be your awards manager? I am sure not an artist, but I think it would be a huge help to the person holding this position. I am however a pretty good worker when I know what to do. I was asked by your new President, Ken Evans, with your past President, Dick Pascoe lurking in the background. So blame them, and I am sure you will be our next pick for Awards Manager. I am sure most of you know the drill, you are asked, don't know what is involved, and you don't know how to say no. Ken said, there is nothing to it, just take the applications and fill out the template, hit print. Oh man oh man, do I wish it was that simple.

It took a few months to get going, and I want to thank Jeff Embry for shipping the records and templates to me! You don't know how important that was to get going. I had a back log, but am now caught up! I plan on staying this way from now on. Usually when I get an application I try to do it that night and get it in the mail the next business day. So if you have sent in an application and not received a certificate please drop me an e-mail. I am good on both QRP ARCI web page and also on QRZ.com. We had a few applications slip through the crack, but I jumped on these when I found out about them ASAP!

If you look in the past issues of *QQ*, you will see many Award Managers over the years. They seem to last for a few years and then move on. I think the hard part is not cranking out the certificates but finding something to write about here. By the way, speaking of past issues of *QQ*, they are still available! You can order them via the QRP ARCI web site under the Toy Store tab. What a great resource those back issues are!

I bet you never thought I would get around to talking about the QRP ARCI awards program. In case you are new to the QRP scene, our most popular QRP award is the KMPW or known as the Kilo Miles Per Watt. Actually this is three awards into one. We track the 1000 miles per watt, the mode, and the band you made the contact on. It is interesting to track all this and it is a whole lot of fun, but also a lot of work. We are up to over 3040 KMPW awards, and I don't see this ever slowing down! Number 3040 was awarded to WØMRZ. Congrats go out to Michael for being the latest in making KMPW. If you are an active QRPer I would be willing to bet you have a QSL card that will qualify you for this award. Give it a try and please remember, I am here to help.

To find out more about this and all QRP ARCI awards go to the QRP ARCI web site at: http://www.qrparci.org/ and click on awards. The N9SSA Distance and MPW calculator comes right up. If you know your grid squares, and your power, and if it is over 1000 miles per watt just fill out the GCR form on the web site, and send me the application. See, it is not hard at all to qualify for KMPW award. If you don't know your grid square or LAT/Long, go to QRZ.com and click on "Click for more detail." That should give you both the grid locator and LAT/Long information. Also, I bet you might have a device

that will give you the same information. Things like Tom Tom, Garmin, and other GPS devices will have the correct information for you.

Speaking of which, I do verify all the claimed award information, and I have never found one QRP award application that was close to being wrong or in question. Nearly every time the QRPer will short his or her self a few miles compared to what I check. However, they are probably using GPS units instead of the more lax grid locators. The QRPers are sure an honest lot of hams and a joy to work with!

Now bear in mind the web award information is a work in progress, and I am behind getting the information tweaked up on the web site. We are tracking over 33 awards now so there is no way we can have the webmaster post all of these or write about them here. Every issue I hope to highlight an award and share a few stories about QRPers that received the award.

Some of the more popular awards we have to offer in addition to the KMPW are QRP all States, QRP All Continents, Worked All ARCI, 5 Band QRP All Continents, 5 Band QRP All States, Elmer Award, DX award, 5 Band QRP DX, County Hunter, and Grid Square QRP. For more information on QRP ARCI awards program go to the QRP ARCI web site. Being a devout QRPer you do have our web site bookmarked, don't you? If you have any questions the web site doesn't answer, please e-mail me. I am here to help.

Speaking of grid squares, here is an interesting story and the part I love about being your Awards Manager. I get to peek inside the QRP world to see some great achievements, such as Larry, K5ZRK, was awarded number 6 Grid Square award. Now I am sure that by saying Larry's award number some of you guys are going to say a single digit award! Yes, that is right, and now you have a chance to get a real low number like Larry did. Here is what made Larry's award so interesting to me, it was done all on 60m! You say so what, well that is the only band Larry is on, and he is 100% QRP with an Icom 703. He is using two antennas tuned for 60m only, a horizontal dipole and the other one is a vertical. How many guys have you run into lately that are so serious about a single band, QRP, working Grids and States? I bet not many. Most interesting is Larry's use of diversity on his antennas to gain an advantage for that next QRP contact!


QRP Amateur Radio Club International

Grid Square Award

Achievement Certificate

Presented to

Larry Jones, K5ZRK

This is to certify that on the date of April 6, 2009, 2009 submission was made of successful two way communications with 100 Grid Squares while running a power output of 5 watts , All 160 and 60 Meter Band

This certificate is presented in recognition of this meritorious achievement

Award Number

6

Award Manager QRPARCI

Jay Bromley W5JAY

**K5ZRK's 60M Grid Award.**

I learn a lot doing these awards, as you can see Larry's Grid Square QRP award is no exception. Larry and I exchanged a few e-mails in which I learned that 60m has its own gentleman's agreement for a mini band plan. For QRP this is Channel 2. After I sent Larry his certificate I was monitoring Channel 2 and worked him QRP to QRP. How neat to work Larry after I got to know him via e-mail. After I worked him I got on our local 2m DX frequency and got a few more guys to work Larry.

If you have the time in the evening, please listen for Larry on 60m Channel 2 or 5.346.500 MHz. If you have not used 60m before with QRP, I can promise you a ton of fun for your efforts. Remember USB only and set the bandwidth to 2.8 kHz. ERP isn't a concern with QRP unless you have a huge beam. Larry's first Grid Square QRP award was for 100 grids. Work him and see if you are a new grid or state for him. I am sure I will see an All States QRP application from Larry some day soon and it will be on 60m. Stay tuned for that one. I think Larry needs just a few states like Alaska. This time of year that will be a toughie.

I find it interesting that Larry not only sent in the GCR form from the QRP ARCI web site, but included a rather elaborate spread sheet. This wasn't required, but it was very interesting to see who Larry had worked within a grid locator. It is not just about the award, but also learning more about propagation using QRP power. Plus I get to be the first to say job well done!

Till next time,

*73 de W5JAY/Jay*

●●

# Hans Summers, GØUPL—ARCI Hall of Fame 2009

Tony Fishpool—G4WIF g4wif@gqrp.co.uk

I suppose *QRP Quarterly* is read mainly by U.S. hams, so to some members, Hans Summers being inducted to the Hall of Fame this year could give rise to curiosity about Hans's contribution to the QRP scene. In Europe we are more aware of Hans's achievements—especially within the circles of GQRP club and our 2000 member internet conference, "GQRP-L." It is always very gratifying that the Hall of Fame voting panel recognizes achievements in other parts of the world—confirming the "International" part of the club's title.

I met Hans around a decade ago—not long after he began sharing his knowledge on GQRP-L in June 1999. He had been investigating the "Huff & Puff" frequency stabilization method, and he freely shared his improvements with detailed supporting documentation on his website. We discovered him then to be very much in the traditional Elmer mold. Being quite a modest chap, his descriptions on the internet conference and his extensive documentation were there so that his knowledge and experience could be shared—and never to "blow his own trumpet."

I confess that as I've got to know Hans I wonder how he squeezes so much innovation into the same 24 hours that many of us seem to squander (by comparison). Take a look at Hans's website www.hanssummers.com and you will see what I mean.

The "Huff & Puff" work was published in both *Sprat* and the now much missed

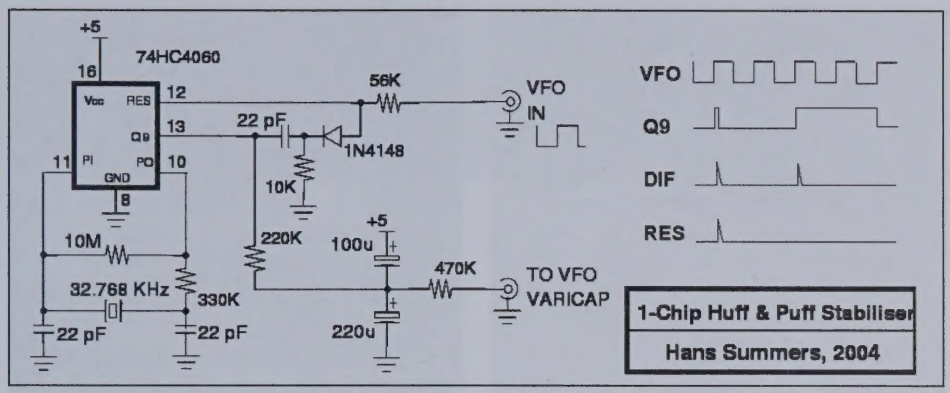



**Figure 1—One-Chip Stabiliser.**

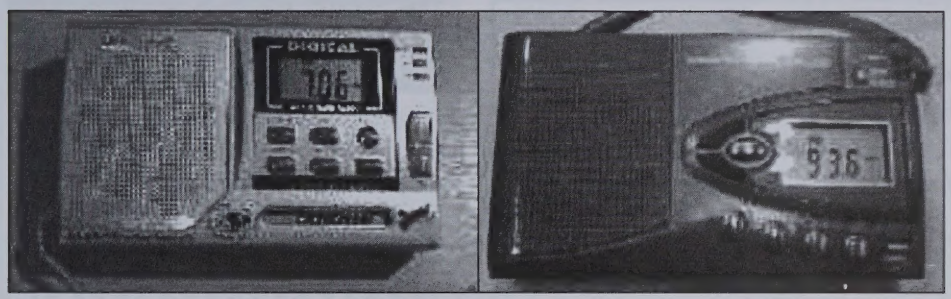


**Figure 2—Superdrug 10-band radios.**

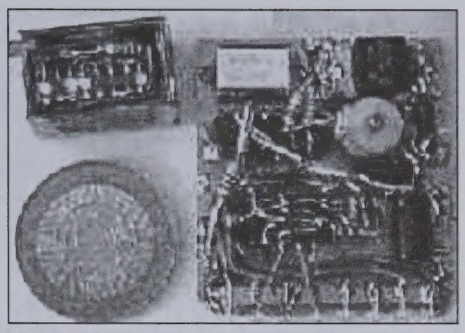


**Figure 3—Mark 1 Frequency Counter.**

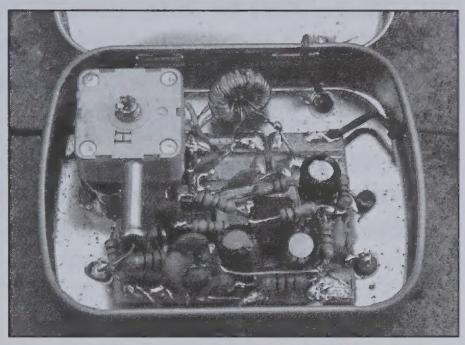


**Figure 4—Junkbox 30M QRSS Tx.**

RSGB "Technical Topics" column in *Radcom*. I particularly liked the minimalist approach of Hans's "1 chip stabiliser" (see Figure 1).

A couple of years ago we had fun in GQRP when we discovered that the European store "Superdrug" was selling 10 band radios for £2.99—later there were versions for £1.99 and even some for less than a quid! (See Figure 2.)

Hans very quickly dissected these radios and worked out how we could adapt them for QRP use. These radios even came with digital frequency displays. What really made it possible for the group to have fun was when Hans patiently traced the circuit diagram and uploaded it to his website. That really got things moving. Even my grid dip oscillator ended up with a digital display and the rest of the radio formed half of a simple 40m rig!

Later Hans became interested in frequency measurement. We've all probably looked at ready built modules that we could add to a home brew radio and found they would more than double the build cost. Hans decided it could be done much cheaper. There were many designs but I liked best his Mark 1 counter, which at the time he calculated that the USA parts cost would be $3.60! (See Figure 3).

It has been said that perhaps his greatest contribution has been promoting QRSS equipment using simple circuits. These designs have also been referenced many times in "Technical Topics" by Pat Hawker G3VA.

Hans devised many new wrinkles for making QRSS very effective. In Figure 4, you can see Hans's "Junkbox 30m QRSS Tx"—built into a mint tin of course! The "Junkbox 30m" running 360 mW was received as far away (from London, England) as WB3ANQ (MD, USA), VK3DI (Australia) and ZL4OL (New Zealand). Hans's antenna? No, not a beam but a long wire in his attic!

My thanks to Nigel Gunn, G8IFF/W8IFF, for Figure 5 showing Hans receiving his award from Dick Pascoe, GØBPS, and George Dobbs, G3RJV. The Reverend George Dobbs, G3RJV, said recently, "Hans Summers, GØUPL, is an inspiration to many QRP home builders. Younger than many of the 'worthies' in QRP, Hans offers us a future for amateur QRP design and home construction."

That says it all. Congratulations to Hans.

*72/3, Tony, G4WIF*

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**Figure 5—Hans receiving his award.**

# Idea Exchange

## Technical Tidbits for the QRPer

Mike Czuhajewsi—WA8MCQ wa8mcq@verizon.net

**In this edition of the Idea Exchange:**

*Breadboarding Quickie (#70), N2CX*
*Thoughts on Stripping Magnet Wire*
*Static Bleeder for Any Antenna, AD5X*
*Saving Clipped Component Leads*
*A Radial Plate for Cheapskates, K3AN*
*Cleaning Sealed Plastic Switches, KR4WM*
*Some AA1IP Homebrewing Comments*
*Development Boards for Mini Circuit Items, WA8MCQ*
*Hard Drive Destruction Safety Tip, WA8MCQ*
*Reusing a Hard Drive Chassis, WA8MCQ*
*Update on the Pixie High Pass Filter, WA8MCQ*

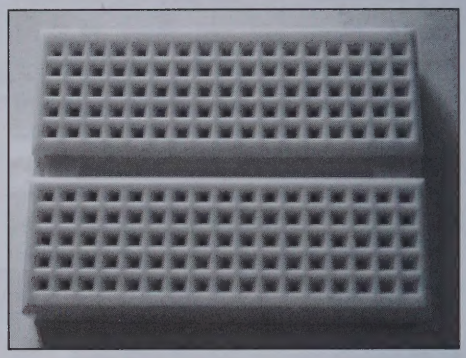


**Figure 2—Solderless breadboard photo.**

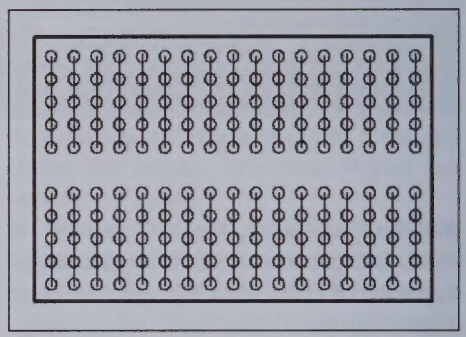


**Figure 3—Solderless breadboard internal connections.**

### Breadboarding Quickie

*Joe Everhart, N2CX, hits another speed limit (at least in some states) with his Quickie #70. (He regrets that events and schedules conspired against him and did not allow better photos to be supplied.)*

Most QRP homebrewers have their favorite technique, and the N2CX workshop has a number of examples of all of them. This Quickie looks at some of the ..errr... quickest ways of breadboarding. A typical simple circuit is built using three methods, and there will be a comparison of their relative strengths and weaknesses. A future Quickie may explore some more permanent breadboarding schemes.

The circuit that serves as the example is the twin tee oscillator from Quickie #1 (Ref 1). As you can see in Figure 1, it is a single transistor 500 Hz oscillator useful as a handy audio test source, a sidetone oscillator or many other applications around the shack. Being simple and noncritical make it a good choice to compare construction methods.

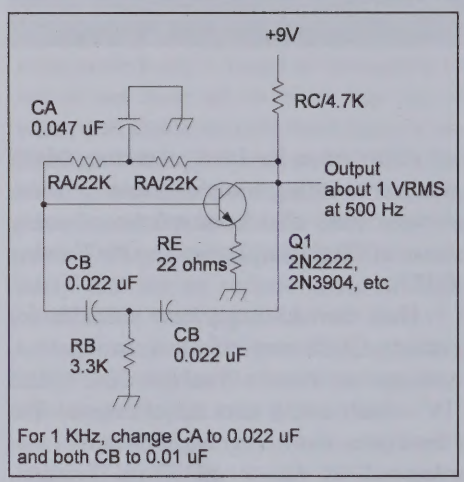



**Figure 1—Twin-tee oscillator schematic. [WA8MCQ drawing]**

### Solderless Breadboards

The first breadboarding method uses what is often called a protoboard, or solderless breadboard (Ref 2). Figure 2 shows a small one, appropriate for circuits the size of the twin-tee oscillator. They are available in a number of sizes (Ref 3, 4) but all share the same basic construction. They have a plastic body with a number of holes on the top surface (with a basic 0.1" spacing) and V-shaped spring metal strips underneath running along the width or length. Wires pushed through the holes are gripped tightly by the V-strips, which provide connectivity between wires in the holes. Figure 3 shows connectivity of the board. Though not used in this Quickie, the gap between the top and bottom rows of holes is sized to allow a DIP integrated circuit to plug in.

For fastest assembly all you have to do is to plug in your circuit's components without needing any tools other than a wire stripper to bare 3/16" or so of insulation on the interconnecting wires. Solid wire is a must and the gauge should be 22 to 24. A few minutes work of trimming component leads and interconnecting wires results in the fairly attractive completed oscillator shown in Figure 4.

Strong points:

- Fastest prototype circuit construction method
- Easy to replace components to select exactly the right value
- Connections between components are clearly visible
- Few tools are needed
- Solderless construction
- Convenient connections for DIP integrated circuits

Weak points:

- Switches, controls and power components need to be mounted off-board and connected with flying leads
- Poor mechanical stability
- Relying on spring tension of V-conductors in protoboards can cause frustrating intermittents

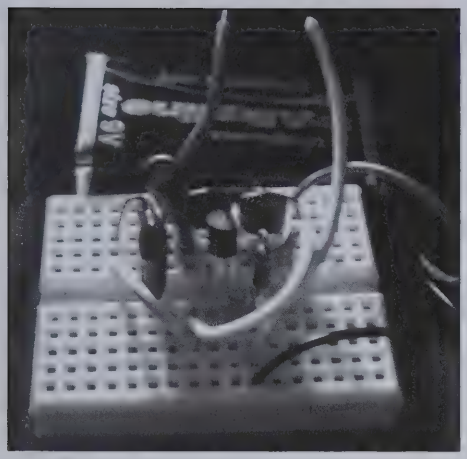


**Figure 4—Solderless breadboard twin tee oscillator.**



**Figure 5—Air-wiring version of the twin-tee oscillator.**

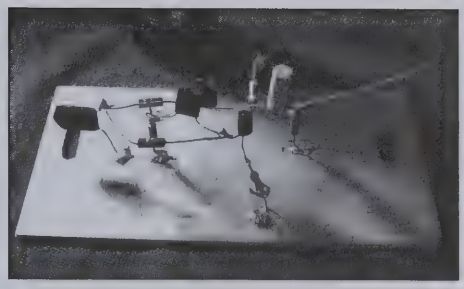


**Figure 6—Ugly style twin-tee oscillator.**

- Poor for RF circuits due to as much as 20 pF capacitance between adjacent conductors, high inductance of interconnecting leads and no way to establish a low impedance ground connection
- Needs adaptors to connect surface mount components
- Not very space efficient

**"Air Wiring"**

The second construction method is truly free-form and nearly as fast as using solderless breadboards. In it, component leads are simply soldered together to make connections—parts are not mounted in any way. This butt-ugly construction method is also sometimes referred to as "ball o' components" style. It is best suited to those times when you're in a furiously creative mood and just can't wait to build a circuit in a more permanent way. One of my favorite stories about it is when a coworker wanted a tone generator to use as a repeater controller. I whomped up the twin-tee oscillator and gave it to him, expecting that he would use the components to build a more rugged permanent version on a board of some sort. Instead, he plopped the components into a paper coffee cup with power and output wires protruding, then filled the cup with a foam type potting compound! The twin-tee example for this Quickie is shown in Figure 5. The nicest thing you can say about air wiring is that it is expedient.

Strong points:

- Don't need anything besides components and soldering tools
- Fast prototyping to prove out an idea
- Can be used with controls and switches if physical stability is unimportant
- Can use power components if a heat sink is employed
- Can use integrated circuits, particularly larger types with long leads
- Connections between components are clearly visible

Weak points:

- No mechanical stability or strength
- Poor for RF use due to long leads and lack of a low impedance ground connection
- Not very space efficient
- Not suited to surface mount components without adaptors
- Poor aesthetics

**"Ugly" Construction**

Ugly style construction is a big step up from air wiring. Popularized by Wes Hayward, W7ZOI, and Roy Lewallen, W7EL, in *QST* magazine and *Solid State Design for the Radio Amateur* (Ref 5), it was a staple of homebrew rigs for a number of years. It combines the point-to-point wiring of earlier tube rigs with much of the free style of air wiring. It uses an unetched piece of copper clad printed circuit board (PCB) material as a base for mechanical reasons and as solid ground plane.

For a free-standing circuit such as a prototype, front and rear panels are made from more PCB material soldered to the base to hold controls and connectors. For finished projects a case is used, either one made by soldering PC board stock together or by using a metal case with the PC board attached to the inside of the case. Components are wired to the controls, and ground connections made by soldering directly to the copper-clad base plate.

Tie points for securely connecting component leads together are made using either circuit parts that happen to have one end grounded or, in their place a 1 megohm or larger resistor soldered to ground. The leakage from high value resistors can be ignored in all but the highest impedance circuits. Having a good ground plane gives excellent RF performance and the presence of many tie points provides reasonable mechanical stability and ruggedness. See Figure 6 for a photo of the "Ugly style" twin-tee oscillator.

Strong points:

- Reasonably fast construction time
- No special materials or tools
- Excellent ground plane for RF circuits
- With good layout, short leads can minimize lead inductance
- Shielding can be soldered to base plate.
- Three-dimensional space can be used for space efficient projects
- Can be built ruggedly
- Power devices can be mounted to panels and wired in place

Weak points:

- Aesthetically lacking except to other homebrewers (when mounted in a case this is hidden)
- Good layout is best done iteratively
- More time consuming to do well as opposed to first two construction methods
- Changing components nested deeply in a 3-D circuit can be time consuming

Three methods have been compared to construct homebrew electronic circuits.

These methods emphasize speed of construction while giving choices as to permanence and low frequency vs. RF performance. Examples are shown to aid in deciding which might be the appropriate choice for a given project. However, there are other construction techniques that offer additional advantages for more attractive construction as well long term ruggedness. A future Quickie is planned to discuss yet more homebrew construction choices.

**References:**


1. Joe's Quickie #1, Audio Oscillator, in the WA8MCQ Information Exchange column. *QRP Quarterly,* Jan 1991.

2. Per Wikipedia: http://en.wikipedia.org/wiki/Protoboard

3. http://www.allelectronics.com/index.php?page=search&search_query=breadboards

4. http://www.web-tronics.com/breadboards-prototyping-boards-solderless-breadboards.html

5. *Solid-State Design for the Radio Amateur* (Newington: ARRL, 1976 and 1997); excellent out-of-print book. Still available at ham flea markets.


*—DE N2CX*

**Thoughts on Stripping Magnet Wire**

*WAØUWH tossed out this question on the online QRP-L mail reflector (the one at qth.net)—*

"You do it, I do it, we all do it, but, how do the experts do it? That is, how or what is the easy way to strip the enamel insulation from the end of small wire?

Currently I use a sharp knife, but as I grow older I keep needing stronger glasses, my QRP toroidal coils grow smaller, and while building smaller SMD QRP systems, I need shorter inductor leads—I find stripping the insulation on very short wires with a knife difficult. I now strip much longer wires and then cut them short, but that does not always work well.

Is there a tool, a chemical, heat or a solvent that can be used? I am looking for a better way; how do you do it?"

*From WAØITP*—I'm no expert, but I crank up the soldering station, scrap a little insulation off with a hobby knife, carry a glob of solder on the tip to the partially scraped wire, and run the bead up and down a few times. It usually burns off the remaining enamel and tins the lead in one step. The higher heat helps.

*From W8DIZ*—The trick to tinning magnet wire is to find a good way to remove the insulation first. With some magnet wire the insulation will melt off as soon as it is heated. This stuff is easy to tin. Just heat it with your solder pencil and apply solder at the same time. However, if you have the other kind of wire, there is a method that I use to remove the insulation.

Obtain a medium size, sharp pair of wire cutters, also called dikes by some electricians. Some folks also call them side cutters. The best ones are cutters that have beveled jaws.

Hold the dikes in your right hand, placing your thumb on the side of one of the handles, your index finger between the handles and the other three (I hope) fingers on the other handle.

Practice opening and closing the jaws by moving your index finger up and down between the handles. The idea is to be able to insert a wire into the jaws and grab it without nicking or cutting it.

After you are barely holding the wire in the jaws, pull the wire thru with your left hand, constantly monitoring the pressure with your right hand. Repeat this procedure, rotating the wire in the jaws.

With repeated practice, you should be able to strip some, most or all of the insulation off the wire. Once you have removed half or more of the insulation you can tin the wire, which will usually remove any remaining insulation.

When stripping and tinning toroid wires, do it all the way to the body of the toroid. Many times the insulation is not stripped all the way, so when you insert the wire into a PCB hole for soldering the insulation is still on that part of the wire that penetrates the hole, not making a proper electrical connection.

*From AB2ZA*—Usually I scrub the insulation with a needle file. It is much safer than a knife, less danger that the wire will break. Just pull the wire a couple of times between your thumb and the file. Second favorite solution, burn the insulation with a cigarette lighter.

*From W2SH*—I am quite opposed to using any metal tool with a sharp blade or surface to scrape away enamel insulation, for it is too easy to nick the soft copper wire if the tool is held at an incorrect angle or applied with too much pressure. Also, I dislike gunking up my soldering iron in attempts to rub off the enamel while applying heat, and these efforts are usually only partially successful.

Worst is holding a lighted match under the enameled wire, for that will, in the case of the finer gauges, destroy the temper of the copper with the risk that it will then break when the inductor is mounted.

Given my unsatisfactory results with all of the above methods, experience has led me to this entirely successful technique: Cut sandpaper of varying grits—fine, medium and coarse are really enoug—into rectangular pieces no larger than 1 1/2 × 3/4 inches. Each of these is folded in half to form a square, with the abrasive surface facing inward. Pinch the portion of the wire to be stripped with the folded sandpaper and drag it once towards and over the wire's free end.

In order to completely remove the insulation, the sandpaper needs to be rotated three or four times in relation to the wire between drags so that all of the wire's periphery will have met the sandpaper. The finer grit squares must be used for finer gauge wires, for too coarse a grit will grab the wire and break it, whereas on heavier gauge wire too fine a grit will require multiple passes to do the job.

**Static Bleeder for Any Antenna**

*K5EST alerted the 4SQRP mail reflector to this article. It's by prolific author Phil Salas, AD5X, and you can find it on his web site at www.ad5x.com. Click on Articles, then look under Antenna Tuners and Antenna Accessories. (Although not everything is QRP related, he has quite a few interesting articles.)*

Many antennas don't have a means of bleeding off static build-up. This includes the popular Hustler BTV-series of verticals, dipoles without transformer-type baluns, and many other antennas. While this is typically not much of a problem, I am always concerned about possibly damaging my antenna analyzer when I first connect it to an antenna. How often have we heard that an analyzer has been blown by static on the antenna?

To minimize the possibility of analyzer damage, most analyzer manuals caution you to momentarily ground the antenna feed before connecting the unit to eliminate any possible static-related failure of the analyzer. So because I am always experimenting with antennas and I have



**Figure 7—A single bleeder resistor ready for installation.**

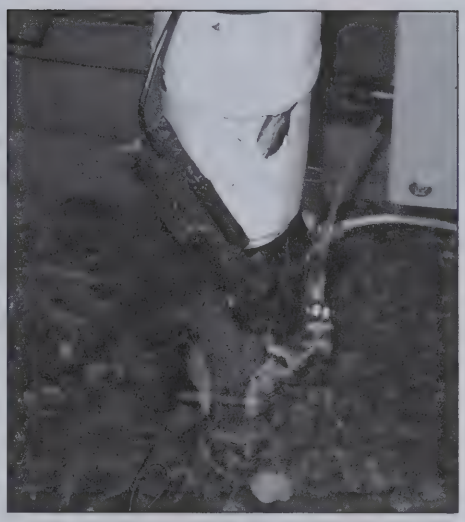


**Figure 8—Three bleeder resistors in series at the base of a vertical.**



**Figure 9—A kitchen sink strainer makes a handy radial plate.**

expensive AIM4170C and AA-200 analyzers, I wanted to always make sure there would be no static-related problems to worry about when measuring my antennas. My solution is to permanently connect a high voltage, high value resistor across the feed point of all my antennas.

For the resistor, I use the Ohmite Maxi-Mox™ MOX-1-123004F thick-film resistor, which is perfect for this application. This resistor is rated at 10 KV and 3 megohms, and costs $5.30 in unit quantities. It is readily available from www.mouser.com, Mouser part number 588-MOX-1-123004F. Normally you'll just need a single resistor, but if you run high power to a highly reactive antenna (like a 43-foot vertical on 160 meters), you might want to put 2 or 3 of these resistors in series. Figure 7 shows a single resistor ready for installation on my 20/15/10 meter dipole. Figure 8 shows three resistors in series, covered with liquid electrical tape, mounted at the base of my 43-foot vertical. Spend a few dollars and stop worrying about damaging your antenna analyzer.

*—DE AD5X*

**Saving Clipped Component Leads**

*WAØITP threw out this question recently on QRP-L (the one at qrp-l.org)—*

"How many hoarders, like me, can"t bear to throw away the cut ends of component leads? What do you do with them?"

*From K7ON*—No doubt like many others, I build things for which no PCB exists. For me, I usually build one "prototype" and that satisfies my needs. I use the cut leads as the "runs" connecting "pads" on proto-boards. I can't be the only one.

*From AB9LM*—I don't save them, but I have definitely found myself scrounging the workshop floor for some.

*From NT7S*—Mine get stuck in my foot when I walk in the shack barefoot. This helps me find all of the leads that fell in the carpet.

*From WEØH*—If they are copper, not tin plated steel, then mine go in my scrap copper collection. When I built my Elecraft K2, the assembly manual suggested using some for the ground test points on the various board assemblies. The diode leads were good for that.

*From W3FPR*—I don't hoard them, and most of them end up in the waste can. But I do keep a small bag full of them to use as short wires or soldered onto a connection that I want to monitor (and the normal lead is not sufficient to attach a clip)—they just come in handy sometimes. It always happens that I need one just after I have cleaned off the workbench, and that is when I dig into the bag.

*From N4XY*—I make it a point to save gold plated leads (such as those from many MIL TO-5, etc., transistors) because they make such a gorgeous finishing touch for above-board jumpers and tie-points for measurement terminals on circuit boards, and so forth.

*WA8MCQ comments, not posted online*—At work and home I occasionally build things on unclad perf board with through hole components. Leads go through the holes, are bent over and pushed down against the board, routed and soldered onto other components as needed, and are finally cut off. The clippings are useful when additional wire is needed to connect some points. They are also good for recycled components which have very short leads; wrap the clipping around the lead, solder, snip off the remainder of the component lead (if any) and connect the clipping wherever it has to go.

**A Radial Plate for Cheapskates**

*With the slogan "ham radio on the net," www.eham.net is an interesting and popular ham site with news, articles on various ham topics, commentary, and a lot more. This antenna related article by Bill Savage, K3AN, appeared there a while back—*

A well-known ham antenna manufacturer sells a stainless steel plate that's designed to mount to a vertical antenna's support mast and provide connections for at least 60 ground radials. It appears to be a well-made product and has gotten good reviews here on eHam.

However, it's rather expensive and considerable overkill for my inverted-L installation, so I set out to look for something that could serve the same purpose at a lower cost. What I ultimately found is remarkably cheap, and should meet the needs of anyone who doesn't have the time, real estate, or inclination to put down more than 30 ground radials.

What is it? It's nothing more than a replacement kitchen sink strainer that you can buy at Home Depot or Lowe's for about $2.00. It's made from stainless steel and is "pre-drilled" for 10-24 size screws. You can readily install ten screws and nuts in the outermost ring of holes, and another five in the next ring. Install two solder or crimp-type terminal lugs under each nut and there's your 30-radial capacity. Furthermore, as shown in Figure 9, the strainer's center hole is large enough to fit over a copper-clad ground rod. You just have to remove the rubber stopper and pull out the metal center stem.

In my installation, each screw is fastened to the strainer with a compression

lock washer and nut. Then the radial lugs are placed over the nut and secured by a second nut. To prevent "galling" or seizing up of the stainless hardware, I placed Noalox grease on the screw threads. I also placed some grease on the flat surfaces of the lugs. Home Depot and Lowe's carry Noalox in the electrical section.

Depending on how many sets of stainless hardware you buy, the total cost for the strainer, the stainless steel screws, nuts and washers, and a small tube of Noalox will be under $10 to maybe as much as $16. For that price there's no excuse for not sprucing up (and adding to) your vertical's radial system.

*—K3AN*



**Figure 10—The sealed plastic switch has no way to get contact cleaner inside.**

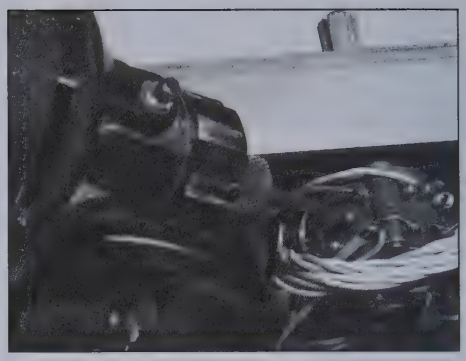


**Figure 11—Drill a small access hole with a dental bur.**

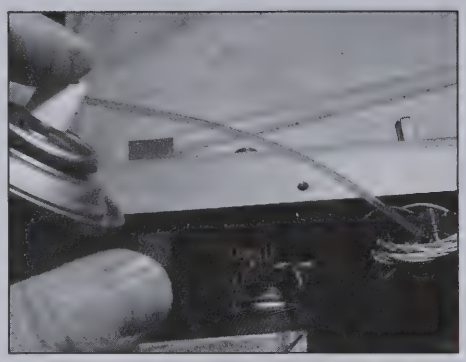


**Figure 12—Spray cleaner into the hole and rotate the switch a few times.**

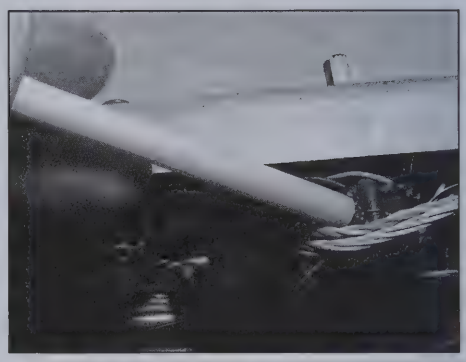


**Figure 13—Blowing through a straw to remove remaining liquid.**

### Cleaning Sealed Plastic Switches

*This article by Web Williams, KR4WM, originally appeared on eham.net, where it was titled "Field Expedient Method to Repair Sealed Switches."*

I inherited a Yaesu FRG-7700 from one of my elmers (W3VT, Bob Cheek). It had a problem with the MODE switch when I received it, and as time passed, the problem got worse. Every time I wanted to listen to it, I had to fiddle with the switch to get reception. One Sunday the problem got so bad I decided to do something about it.

Assuming it was an open frame switch, I grabbed my can of De-Ox-Id and opened the cabinet. (I always lay out a soft white towel when working on radios. It helps to find dropped small parts, and keeps the radio from getting any new scratches.) Don't have any De-Ox-Id? You should keep a can of this in your radio tool kit. It has all sorts of uses! It's GC part number 19-1906.

Upon opening the cabinet and getting to the part, I discovered that it was a sealed unit (Figure 10). It was completely closed and riveted shut. I began thinking—what might this part look like internally? It had to have an ordinary wafer switch inside; I just need to discover a way to get this De-Ox-Id in there.

I found a spot on the perimeter that had no contacts, and considered drilling a hole in the side of the switch to get access. The case was plastic, so using an ordinary drill was not an option. A regular drill bit will sometimes catch and pull itself into whatever you're drilling, sometimes destroying whatever it comes into contact with. It will also sometimes act as a wedge, and could possibly crack the plastic case.

Knowing the age of this radio, and fully realizing that if I destroyed this part it would be almost impossible to replace, I knew I needed something other than a drill bit to make the hole. Enter a Dremel tool and a dental bit! These bits are available at many hamfests, and come in handy for all sorts of jobs. I found a very tiny one that would make a hole just large enough to insert the spritz straw that De-Ox-Id comes with. Setting the Dremel tool on as low a speed as it would go, I cut a tiny hole in the side of the switch (Figure 11). Afterwards, a few quick spritzes in the hole while rotating the switch through it's range of motion quickly cleaned all the contacts. (Figure 12)

After spritzing the inside I used a drinking straw to concentrate my breath and dry up any liquid left behind, being careful not to deposit too much moisture from my breath (Figure 13). A can of dry compressed air would work better, but I didn't happen to have one. Rotate the switch while blowing air into it to aid in cleaning the contacts even more. De-Ox-Id is designed to be left on as a contact lubricant, and need not be removed.

I hope this method helps you save a radio that otherwise might end up in the trash pile because of obsolete parts!

*—DE KR4WM*

*WA8MCQ comments*—He mentioned GC part number 19-1906, a 4-oz. aerosol can. It's also available from some distributors as GC 19-1902, a 2-oz. bottle of liquid.

Comments on eham.net articles are allowed, and most of them get quite a few. A couple on this article were about potential for confusion since there is a similar product with a very similar name.

*From KT8K*—Actually, "De-Ox-Id" is a spray contact cleaner from electronic-related products supplier General Cement, is relatively inexpensive, and was once widely available among electronic parts sellers (most long gone). "DeoxIT," on the other hand, is a high-end contact cleaner from CAIG Laboratories. I have used both and far prefer the CAIG products, but the GC cleaner does work. I just found that in some applications I had to be ready to reapply it every 6-12 months. The CAIG

product, while much more expensive, has never required reapplication. That's just my experience—nothing scientific about it—but I thought I'd fill in as an earlier comment [not included here] seemed confused by the very similar product names.

*From AF6AY*—I used GC "contact cleaner" decades ago as an ardent hobbyist and once-in-awhile part-time TV repair money-grubber. It was never formulated for "long life" by the original chemical formulator (GC repackages a lot of things, buying other companies' products in bulk). Its "cleaning action" is primarily as a lubricant which, accompanied by an unpleasant odor, makes the user THINK they are cleaning something.

On the other hand, from listening to a lot of folks in the entertainment business, primarily in "post-production houses" in/around Los Angeles (over 300, last I heard), the CAIG products are long-lived with little need to re-apply their cleaners. To explain, older audio mixing consoles would have multiple contact, continuously rotating (no mechanical indexing) "potentiometers" carrying low-level audio.* Contact noise would be readily apparent if it was there. Post-production companies in a very competitive market couldn't afford to spend time "fixing" noisy audio (and later, video) electronics.

(* Those old Pro gain controls are very-limited-application "potentiometers" that originated in motion picture sound production early in the 1930s and spread quickly to audio broadcasting and phonograph disc recording to become a mainstay of "gain riders" controlling audio. They have fixed resistors and lots of multiple taps, each tap having multiple contacts on rotors, with the resistors usually in Tee configurations for low impedances (typically 600 ohm in/out), contact metal alloys picked for a compromise of minimum oxidation and wear. They would usually outlast the employment time of any gain-rider using them. Costly, a single replacement gain control would cost more than a new retail-price Hallicrafters S-38 back when Halligan's company introduced that receiver. Some of those same gain controls are still alive and working today in broadcasting and recording. S-38s are now "operating" on e-Bay.)

While the ancient (pre-WWII) rotary gain controls were nearly always sealed, the in-line "slider" types were more open by their control tab slot (seals would eventually wear out before any contacts got bad). Folks around here in the entertainment capital of the world don't want to fool with products that don't do their job. That's where CAIG and a few of their contemporaries stepped in with superior products.

GC products were once "popular" (their name known) with hobbyists because they were relatively cheap and distributed through "radio parts stores" and had lots of advertising in radio/TV magazines. Only a few GC products are, in my opinion, worth their price: A fine design wire stripper flawed only by inattention to quality control on a spring (I had two, both with the same spring break failure); Corona dope, fine for 15 KV and up lines but displaced by much lower voltage display technology; Strip-X, one of the easiest-to-use magnet wire de-enamelizers ever.

*—DE AF6AY*

**Some AA1IP Homebrewing Comments**

*Recent e-mail from Brad Thompson, AA1IP—*

Here are a few ideas for your column. Please note that I haven't implemented the rack-and-pinion concept.

While scrapping a paper tray for an HP LaserJet III printer which I no longer owned, I noticed that the tray includes a mechanism for adjusting paper width that comprises two 5 1/2-inch long plastic racks driven by a small plastic gear measuring approximately 7/8 of an inch in diameter.

The toothed portion of the rack measures 4 inches in length and would provide approximately 3 1/2 inches of linear travel for 1 1/2 gear rotations. While probably not suited for adjusting VFO frequency, it occurred to me that the mechanism might work well for changing the position of the tuning core in an antenna tuner.

Having limited mechanical skills, I'll leave construction details to interested readers.

Don't overlook castoff satellite TV receiver boxes as a source of components for QRP projects. I recently scrapped three of these and recovered the following:

*Echostar DP301:* one 4.9152 MHz surface-mount, one 13.500 MHz through-hole, and one 10.11 MHz surface-mount crystal. The last item resided in the tuner enclosure.

*Thomson-CSF DRD420RE:* one 4.5 MHz ceramic filter, one 4.000 MHz crystal residing in the tuner enclosure, one each 16.000 MHz, 15.047880 MHz, and 15.263330 MHz crystal.

*Thomson-CSF 4000:* one 27.000 MHz crystal oscillator module, one 12.000 MHz crystal, and one 16.00031 MHz crystal.

These set-top boxes also yield various passive components and a switched-mode power supply, which, while not recommended as a QRP power source because of noise emission, will generally cough up various ferrite chokes and inductors and a high-voltage power MOSFET that might work as a QRO-QRP final.

*—DE AA1IP*

**Development Boards for Mini-Circuit Components**

Development boards are sometimes offered by manufacturers as a way to easily test and experiment with some of their products. I was going to try to make one of my own to test some surplus surface mount mixers I picked up but wasn't looking forward to trying to make one that gives a good 50 ohm environment across a wide frequency range. I especially dreaded having to make a large number of closely spaced connections between ground planes on both sides.

Being an old cheapskate, I was about ready to forget about testing the mixers rather than shell out the money Mini-Circuits wants for one. But then I stumbled across some inexpensive ones offered by an eBay dealer. I haven't had a chance yet to test one of the bare boards across a wide frequency range with some precision 50 ohm SMT resistors in place of a mixer, but they appear to work well with the mixer I tried.

The eBay vendor name is "rfextra," and I've dealt with him a few times over the years. He sometimes has things offered for auction and also has an eBay store. Your best bet would be to go directly to the latter and look at store category Develop PCB. He has these available in several different layouts, all for surface mount parts only, and since a lot of Mini-Circuits items share common footprints they can be used for many different part numbers. The one I bought first was listed as "Develop PCB

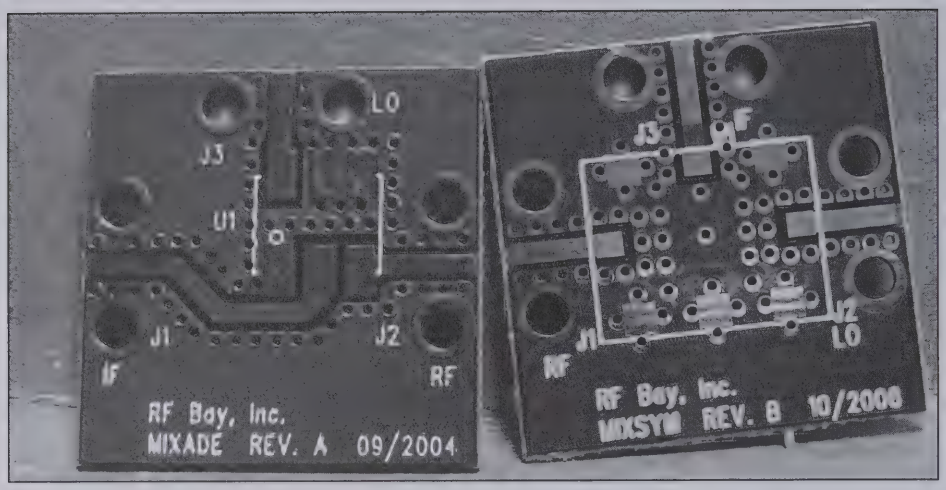



**Figure 14—Two inexpensive development boards for SMT mixers.**

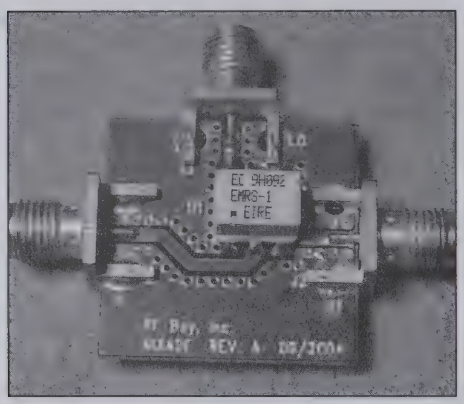



**Figure 15—One of the boards with connectors and a mixer added.**

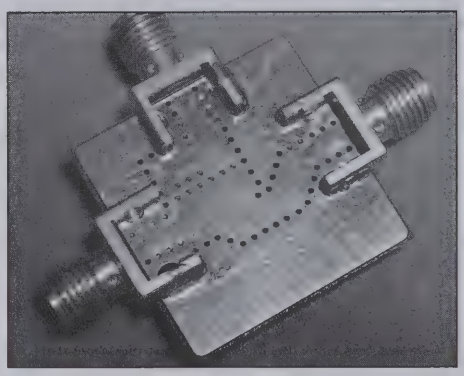


**Figure 16—Bottom of the board. Drill holes in the corners for mounting if desired.**

for Mini-Circuits ADE/JMS Mixer," and he lists 37 parts in the two series that it works with. (In the case of two of them, the RF and IF pads are reversed; just mentally flip the markings screened on the board.)

He currently lists 18 different development boards for mixers and other devices, all priced at $9.99 per package. For that price you get either 2 or 4 boards, depending on what it is. Please note that this is for the boards only, and does not include the mixer or other device, or any other components that some devices such as amplifiers may require. You also have to supply your own SMA connectors. Figure 14 shows two of the bare boards, different types, and Figure 15 is one which I populated with a mixer and edge mount SMA connectors. (The mixer is an EMRS-1 from M/A-COM, which has the same footprint and connections as the Mini-Circuits mixers the board was designed for.) The name on the boards, RF Bay Inc., appears to be a small business that he operates, and has it's own web site, www.rfbayinc.com.

A mixer mounted on one of these boards with connectors would come in very handy for experimenting on the bench. Since the boards are fairly thin the resulting assembly is relatively fragile, so you can't get as rough as you might with a packaged mixer. One possibility would be to mount it to a small piece of scrap aluminum to stiffen things up a bit. As Figure 16 shows, the bottom is a solid ground plane but the legs of the connectors don't allow mounting directly against metal; nuts or other spacers could be used. Since the holes of the bare boards are covered up by the connectors, small holes could be drilled in the corners.

The locations of the holes in the board make a little more sense if you look elsewhere in the eBay store, under Designer Kit. Those consist of one of the boards plus a small milled aluminum box, connectors and hardware to assemble your own connectorized device. (You have to provide your own module and other components.) The board is mounted in the box with screws in the holes, and the SMA connectors are mounted to the box; in this case, only the center conductors are soldered. You can view completed units under store category RF Module.

The usual disclaimers apply; I have no connection with the vendor and in no way warrant his offers, although I've bought a number of things from him over the years. (All we have in common is that we live in the same state.)

*—DE WA8MCQ*

**Hard Drive Destruction Safety Tip**

The pile of old hard drives was starting to get big, and I wanted to dispose of them in a way that would keep anyone from getting any useful data. I disassembled them completely, taking out the platters and voice coil magnets. I thoroughly scrubbed both sides of each platter in small circular motions with one of the magnets, which are very strong, hoping that it would scramble anything on them.

Next, I folded the platters in half, using a pair of pliers to flatten the fold. As the platter is folded you can see, hear and feel the magnetic coating crack; it doesn't flake off, but all of the stress cracks can't be good for it. The pliers contribute additional damage in the form of scratches and gouges. Finally, I repeated the process twice, ending up with each platter folded into eighths and enduring massive trauma along the way (Figure 17, which also shows the magnets from the drive). That should keep my personal data out of the wrong hands.

These were all standard 3.5" hard drives from tabletop computers. When he saw me doing this, my son gave me two additional dead drives to play with, one from his laptop and one from a friend's laptop. These were a much smaller form factor and the platters weren't much more than 2" diameter. After scrubbing them with the magnets from the large drives—the ones in the small drives were weaker—I tried bending one and discovered the hard way that they were glass, not metal.

Fortunately no injury resulted when it shattered in my hands, although it took a good while to clean up all of the broken shards from the table and rug. (And it was not like automobile safety glass, which

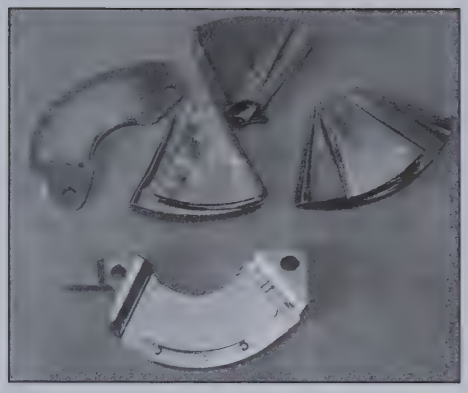


**Figure 17—After wiping with a strong magnet, metal hard drive platters are folded several times for additional security. But make sure they are metal before trying to fold them!**

forms tiny, smooth fragments when shattered. These platters produced a substantial quantity of very sharp and jagged pieces.) And now, knowing that they were glass, it was much easier to destroy the second small drive. I simply pried up the cover a bit to expose the platters, stuck a stout screwdriver inside and wiggled it around to shatter them. (This time around, suitable protection and glass containment procedures were used.)

I doubt that many people remove and bend the platters in their hard drives for security reasons, but if you are so inclined, please make sure that they are metal before bending them. I have no idea how to tell ahead of time which drives have metal and which have glass platters, although the online hard drive article on wikipedia.org indicates that glass is common. (A good way to test a platter would be to wrap it completely in several layers of paper or cloth and then try bending it. Or, if you don't want to bother removing them from the chassis, try the screwdriver trick mentioned above.)

A note about the magnets—they can be very handy around the house and workshop, but be careful since they are quite powerful. If you bring a pair of them close together there is a good possibility of pinched fingers when they slam together. (They can also be hard to pry apart.) And if you have a pacemaker or ICD, it's probably safe to say you should keep them rather far from your chest. (These devices sometimes have to be disabled in a medical setting, and it's done by putting magnets near them.)

*—DE WA8MCQ*

**Reusing a Hard Drive Chassis**

*(This was originally included in the item above, but I split it off so it will appear separately in the table of contents and make it a lot easier to find years from now.)*

In case anyone wonders what connection the above hard drive platter item has to homebrewing—in addition to wanting to destroy any personal data, I also wanted the empty hard drive chassis. They are die cast aluminum with two shallow but large cavities on either side of a central wall, suggesting possible use as a project chassis. I did a bit of test drilling and milling on one (Figure 18). Early results were mixed but there is potential.

Although you can install any additional connectors you wish, they come with 2 free connectors to get you started; just cut off the appropriate end of the PCB and mount it. There is a 40-pin signal connector plus a relatively high current, multi-pin power connector. (This is an EIDE drive; different types will have different connectors.) Tack your wires onto existing traces or pins. It won't be pretty, though; and dealing with any remaining traces and components would take a bit of work, but they do have potential. Figure 19 shows the connector end of the board and a few added items. (This was a staged photo; if these parts were to be actually used, the holes and cutouts would have to be larger.)

The hard drive also comes with a cover (Figure 20, which is actually on the wrong side of the chassis in this photo). It will keep out small rodents that might want to chew on the components, but that's about it. It's not RF tight since there is usually a gap between it and the chassis, covered by a piece of tape around the entire hard drive.

Please keep in mind that all drives are different, changing as form factors evolve over the years. There are also a number of different interfaces, each with a different type of connector. The old ones I had were EIDE with the 40-pin connector, but SATA and SCSI have different types that may not be suitable for you.

I'm not sure if I would actually try building something into one, but they have potential for experimentation. (I was originally thinking of mentioning this concept in the Spring issue, but since that usually comes out in April I was afraid some people might think it was not a serious article.) And having known him for years, using

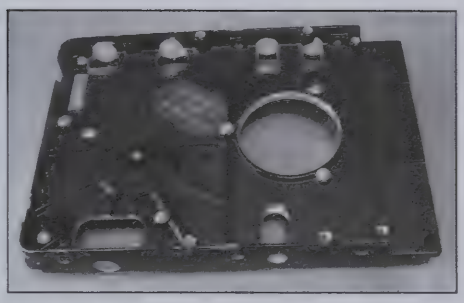


**Figure 18—Everything removed from a hard drive chassis and a few holes milled and drilled.**

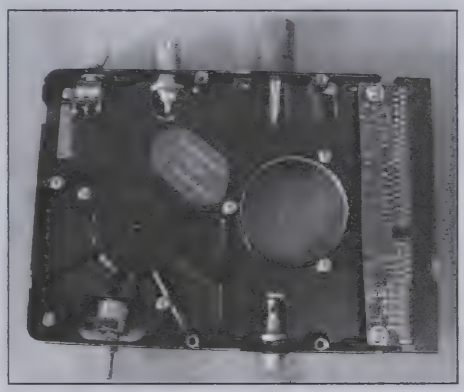


**Figure 19—Connector end of the PCB mounted, along with some typical components.**

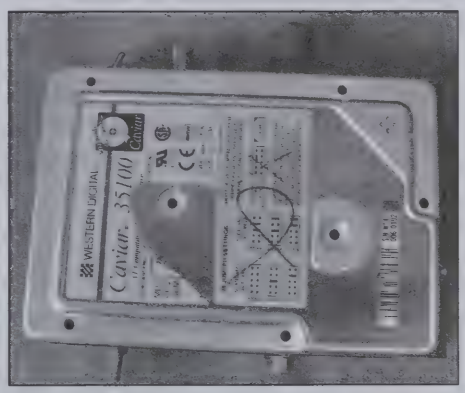



**Figure 20—One side of the chassis has a cover although it is not RF tight.**

one of these for a project sounds like exactly the sort of thing that N2CX of Quickie fame would do!

*—DE WA8MCQ*

**Update on the Pixie High Pass Filter**

The last issue contained an item about a high pass filter for the super simple Pixie transceiver, intended to reduce BCI, interference from nearby AM broadcast band transmitters. As seen in Figure 21, the orig-

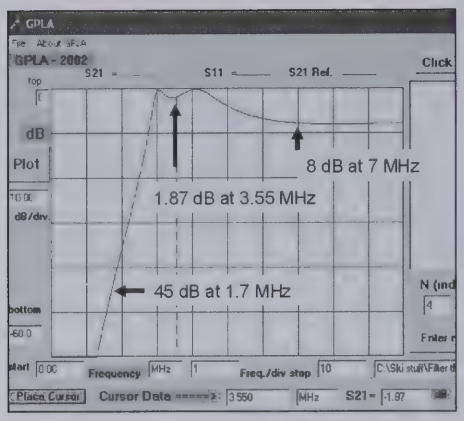



**Figure 21—Frequency response of the original high pass filter from last issue. Insertion loss is significant at 3.5 MHz and even higher at 7 MHz.**

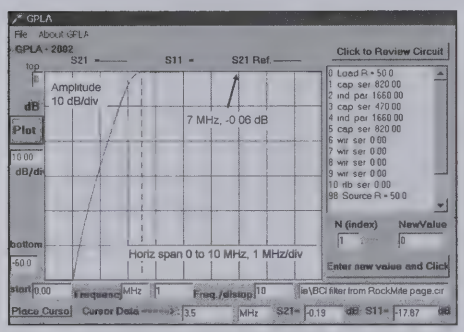



**Figure 23—Response from 0 to 10 MHz. Insertion loss is good at both 3.5 and 7 MHz.**

inal filter design had a frequency response such that it could not be used on both 80 and 40 meter versions of the rig. Insertion loss at 3.5 MHz was rather high but could be brought down by tweaking component values. However, at 7 MHz it was much greater and could not be reduced, so a second filter design would have to be used on a 40 M Pixie.

It would be better to have a single design that can be used on either band, and the values shown in Figure 22 do just that. This was taken from the Files section of the Rock-Mite discussion group on yahoo.com. (That forum was started by Chuck Carpenter, W5USJ, and is dedicated to the simple transceiver designed by Dave Benson, K1SWL, many years ago. The Rock-Mite and it's higher frequency brother the HiMite continue to have an active and dedicated following.) This BCI filter, which is perfect for use with the Pixie, was posted there by NE4LS, and you can't ask for anything better.

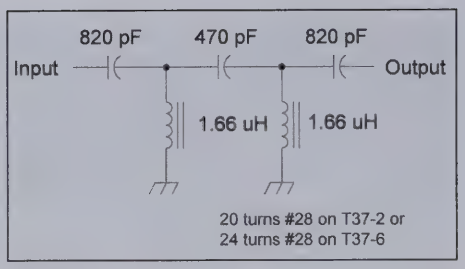



**Figure 22—This BCI filter for the Rock-Mite, from NE4LS, is perfect for both 80 and 40M versions of the Pixie.**

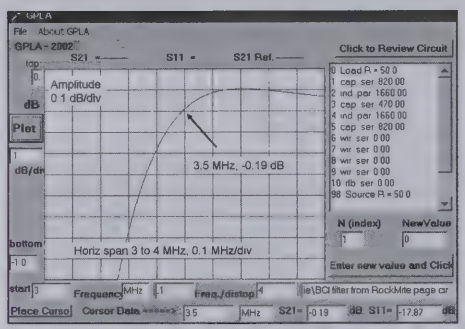



**Figure 24--Insertion loss is low at 3.5 MHz, and even better as you go up in the band.**

Figure 23 shows the response for 0 to 10 MHz, 10 dB per division on the vertical axis with –60 dB at the bottom. Insertion loss at 7 MHz is 0.06 dB. Go down in frequency and by the time you hit the top of the AM broadcast band at 1.740 MHz the insertion loss is 34 dB. It drops rapidly below that point, hitting 60 dB at 1.000 MHz. The closeup of Figure 24 shows a tighter span, 3 to 4 MHz and 0.1 dB per division on the vertical axis. The loss at 3.5 MHz is 0.19 dB, and even less as you go higher in the band.

A couple of weeks after I sent off my last column to the editor I suddenly realized why the original design had a response as shown back in Figure 21. It took quite a while for it to sink in even after I read it a few times, but the web page that the design was taken from indicated that the filter was designed for 200 ohms. When used at 50 ohms instead, it gave the response shown. I plugged some numbers into the analysis software and ran the original design again, but this time with it set for 200 ohms instead of 50. Sure enough, the response then looked pretty much like the one in Figure 23. Moral of the story—always use a filter at the impedance it was designed for.

Frequency responses were plotted with GPLA, General Purpose Ladder Analysis, which was written by Wes Hayward, W7ZOI. It is included on the CD that comes with the ARRL book *Experimental Methods in Radio Frequency Design,* which he coauthored with KK7B and W7PUA. It was also on the CD that came with his earlier ARRL book *Introduction to Radio Frequency Design.* (The EMRFD CD has an updated version of his software.)

If you have a Rock-Mite, Pixie or other simple QRP rig that is troubled with BCI, this filter should be a considerable help and it can be used without modification on anything from 80 meters and up.

*—DE WA8MCQ*

**The Fine Print**

In the early years of the column I tried to get the editor to actually print this section in a smaller font. Most of them did not, but I kept the name. And it always says pretty much the same thing—if you have anything you'd like to share, get it to me any way you can, in any form (paper, floppy, CD, e-mail), and don't worry if it's not polished or if you just have hand-drawn schematics. Our skilled staff (me) takes care of all of that automatically. All you need to worry about is getting it to Severn. ■■

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# FDIM 2009—What a Blast...

Dick Pascoe—GØBPS dick@pascoes.plus.com

Each year we say it will be better than last year, each year it does get better even if only slightly. This year (2009) was a real highlight for all those attending but even more so for one special visitor—Oleg Borodin, RV3GM.

Since I have been organizing the speakers we have had some real heavyweights sharing their views with us at the seminars. One visitor commented that his employers spend thousands of dollars to send him to seminars to listen to just one speaker of the caliber we have, and we charge just a few dollars.

It should be remembered though that our speakers are volunteers, they actually want to share their knowledge and many consider it an honor to address our club members.

So, to 2009. This year we had a splendid line-up again with Ed Hare, W1RFI, both enlightening and enthralling the crowd and even better giving a talk that entertained as well. His experiences in the ARRL lab and how they tested various items of equipment was very interesting.

Dave Cripe, NMØS, gave a great explanation of Class E amps for QRP, way over my head but enjoyed by many others. The highlight for many is Rev. George Dobbs, G3RJV, who ALWAYS entertains and enlightens. I well remember him starting a sermon in his church, peering out to the congregation he waited for silence and then raising his right hand in the air said just one word—"constipation"—and the congregation fell about laughing.

The death knell for any speaker is the first presentation straight after lunch, but Jan Verduyn, GØBBL, kept everyone awake with his talk about Softrock Radio, another fascinating exposure.

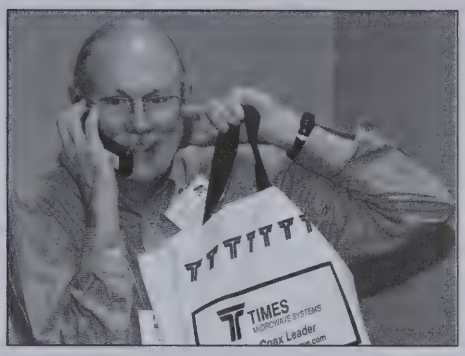
Rick Campbell, KK7B, a college professor who has the enviable ability to make the most complex appear simple, followed and as always both informed and entertained. I always enjoy Rick's visits to FDIM where he is so relaxed in his delivery.

The keynote speaker was the exact opposite as he approached me on the stage after I announced him. Oleg was shaking with nerves as he stood at the lectern. Not surprising as he was about to address a couple of hundred people he didn't know, in a strange country speaking in a foreign language. He was sensational! His hesitant start soon developed into a cool presentation, only halted as he searched for the right word. His nerves fled as he gained confidence. The standing ovation at the end said it all.

As Oleg stepped off the stage we headed towards the evenings events with supposedly just the speakers being available for the "meet the speaker" session. But as usual, several traders set up their tables to do some business, brisk business and lots of US$$ changing hands.

One of the very best changes that the organizers had made was to employ a REAL audiovisual guy to provide a MUCH better audio system for the attendees. Even standing at the back, the speakers could be heard clearly. The twin screens also helped everyone to see what was happening. Thanks to Ron Steinberg, K9IKZ, who was also a member for his wonderful expertise in this field.

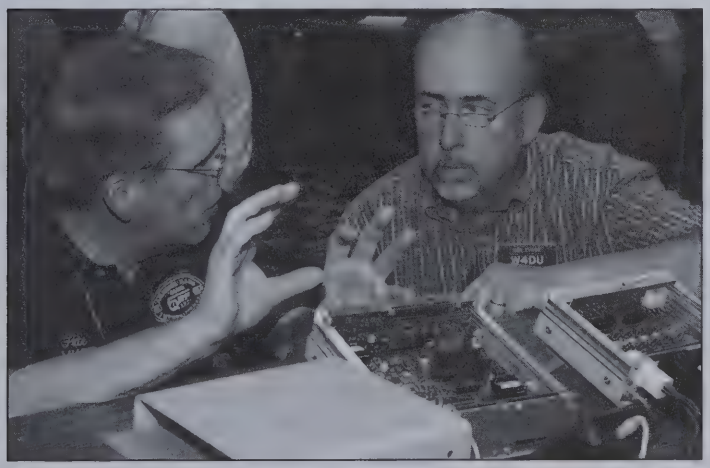
The video streamed web cam was a tryout just to see if it was a viable proposition. Using just a small handy-cam on a tripod the streamed video was jerky the sound unsynced at times but apparently enjoyed by




**Doc, K8WPE, says, "Come join the fun."**



**Nine-year-old Katie Cole, K3SP. puts some solder to the Sudden RCVR.**



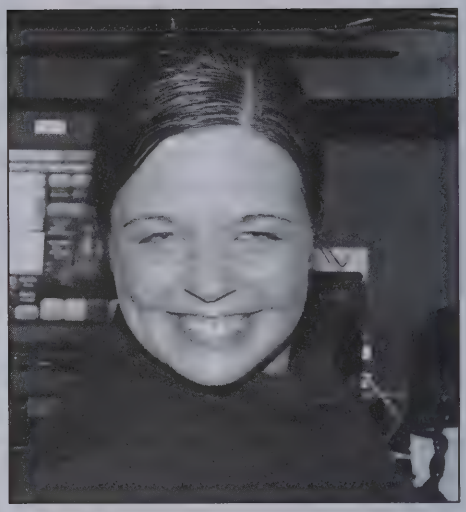
**W8KS demonstrates the newest from Juma to W4DU.**



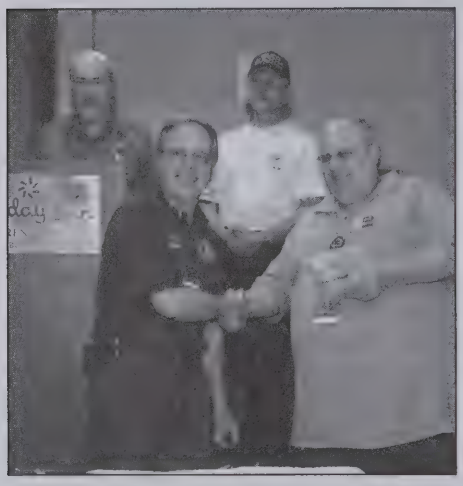
**W1REX provides Elmering to K3SP.**



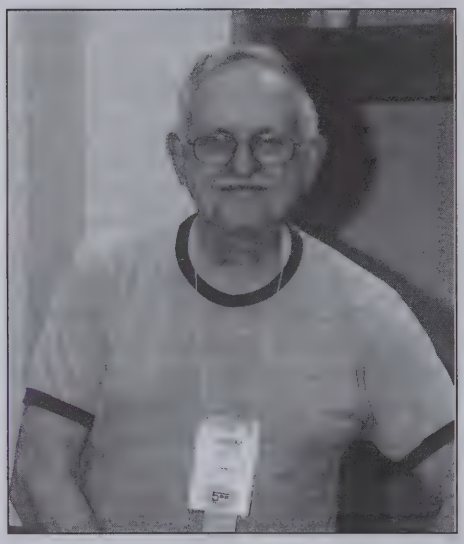
**The Seminar begins.**



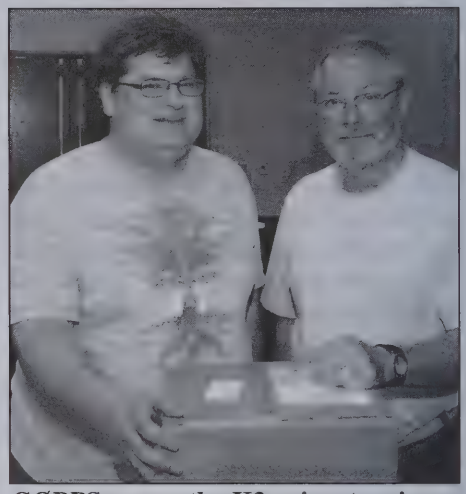
**Many YLs (Ham and non-Ham alike) enjoyed the event.**



**Pete, WK8S, passes a Juma RCVR to winner Mike, WD8S.**



**Joe, WØMQY, registers people for the homebrew contest.**



**GØBPS passes the K3 prize to winner WØUFO.**

those that saw it. We hope to be able to web cast at least one speaker next year and do it much better.

Friday evening saw the vendor night with the ballroom packed with people selling and showing off their equipment. I managed to persuade myself that I really did need one of Vern Wright's three element beams but bought little else except for a nice Brown Bros paddle in the flea market. I gather that most of the traders did well. The building contest went very well. We had entries in two categories this year. The winner in all homebrew was Dave Cripe, NMØS, for his superb regen receiver. The overall winner and winner in station accessories category was Richard Meiss, WB9LPU, with his fully automatic (both dits and dahs!) mechanical bug.

Saturday is always the highlight of FDIM and has for seven years been my opportunity to show off my command of the correct way to speak English, none of this yank stuff for me.

Giving away several expensive radios such as FT817, an Argonaut HF rig and a K3 and I didn't win any of them!

For me the very best part of FDIM is the Hall of Fame inductions. The nominations often come in slowly with occasionally just one or two. This year there were more and the judging was VERY difficult. I always look at those nominated and try to judge them against Doug DeMaw and Rev Dobbs. Are the nominees in the same class? Of course they are not, but often there have been nominees that have stood out head and shoulders above their peers.

Several years ago I stated that it was not a requirement to have ANY inductees at FDIM and one year we did have a blank. This year there were four nominees and every one deserved their place in QRP HOF. Those inducted this year were; Richard Campbell, KK7B; Martin Jue, K5FLU; Tony Parks, KB9YIG; and Hans Summers, GØUPL.

I took great delight in announcing that Ken Evans, W4DU, would be taking over as the new president of QRP-ARCI. He then told the audience that Kathy Bromley, WQ5T, had been elected as vice president. I am certain that they will work well together and the club will continue to flourish.



**Martin Jue, K5FLU inducted into the QRP Hall of Fame by Dick, GØBPS.**



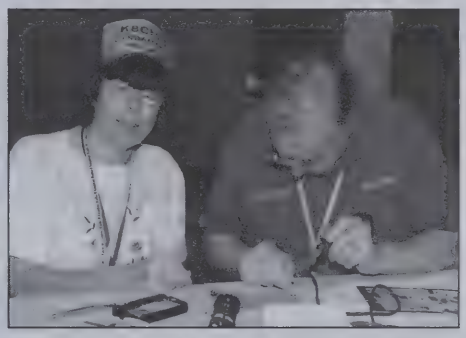
**Oleg, RV3GM presents George Dobbs, G3RJV with an RU QRP Special Achievement Award.**



**M Cubed shows their latest creations.**



**Some of us get stitched.**



**Cyndamarie, K8CMG gets buildathon help from husband Nigel, W8IFF.**

This was my 21st visit to Dayton and I got bored with the Hamfest many years ago, yet I just love FDIM, the ambience, the friendship, the great music and seeing old and making new friends. The changes in the hotels from the old Knights Inn at downtown Dayton, The Days Inn, later the Ramada at Middlesburg South Dayton and when that got pulled down the best of the lot at the Holiday Inn.

2009 was extra special for me in many ways. It was my own finale, my last one as president. I had presided over FDIM for seven years, far too long. There was a tear in my eye as I stepped off the stage and bade goodbye to a job that I loved.

*Dick Pascoe, GØBPS*

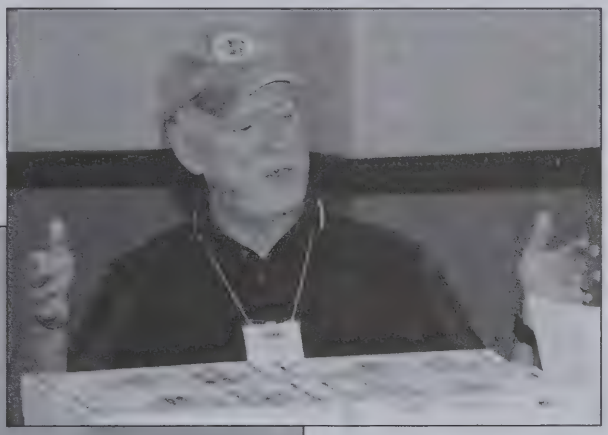
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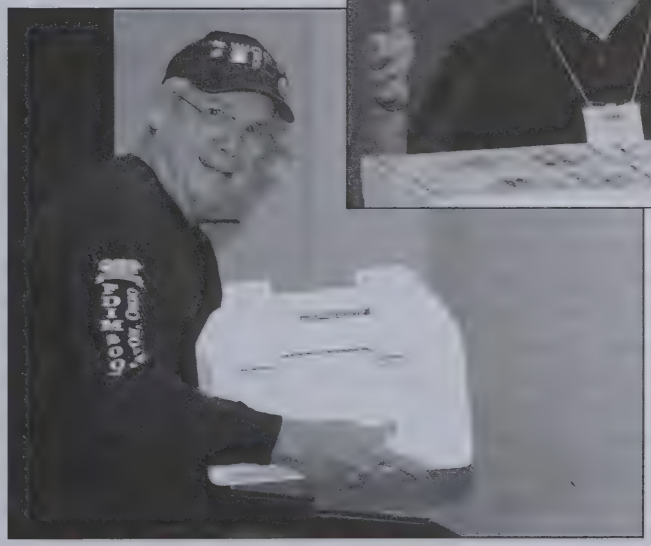
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**Melodey, KD8KQZ shows off her FDIM badge.**

**How big is that, Chuck? (AE4CW)**





**Jim, W4QO helps out with some heavy lifting.**

# FDIM 2009 Buildathon Report

Ken Evans—W4DU

w4du@bellsouth.net

Each year, various clubs and vendors have hosted a buildathon at FDIM. All have been targeted at beginners and have used a kit to help them learn basic skills. This year, GQRP and QRP ARCI hosted the buildathon and decided to step away from the kit and use a quasi-Manhattan style homebrew project to help new comers get involved with homebrewing. We were unsure how this project would be received as we could not find anyone that had used manhattan as the focus of a buildathon. Also, since we seemed to be "plowing new ground," we had no history to tell us where to focus our energies to ensure the novice builder had a successful experience. The initial team was George Dobbs, G3RJV; Diz Gentzow, W8DIZ; Rex Harper, W1REX; and I. At the actual event we had these four plus six additional people to help the builders. The interest in the event as well as the success of the builders surprised us all. We had 32 people participate and had to turn away 8 others (we simply didn't have the room). Thirty-one people were successful in completing the project; one took it home to finish and get it working. The one big lesson learned is that there is a great deal of interest in building in general and specifically homebrewing by both newcomers and veteran hams. The rest of this article describes the project and how we provided help, and it gives a challenge to local clubs to tap into this desire to build by organizing a building event.

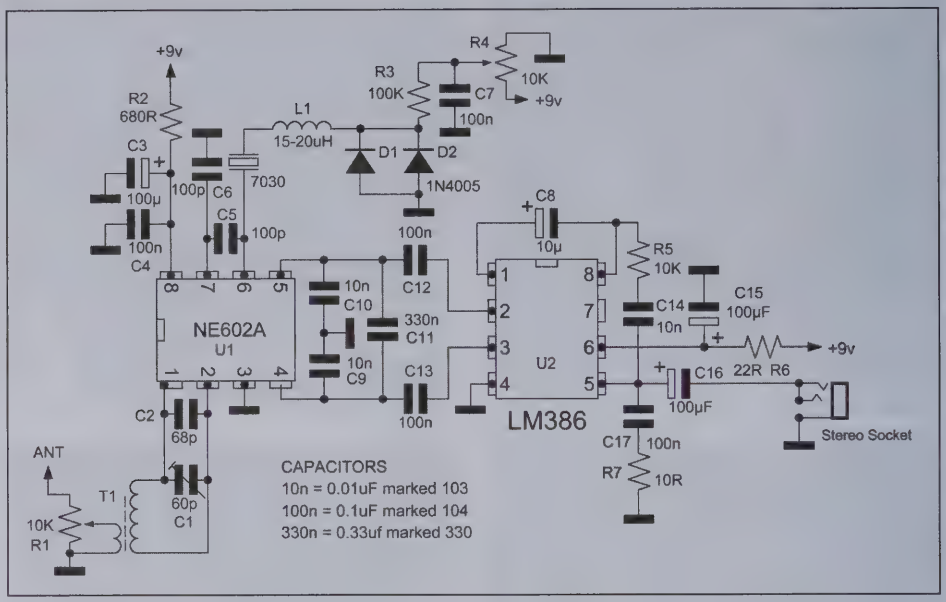



**Figure 1—The Sudden receiver schematic.**

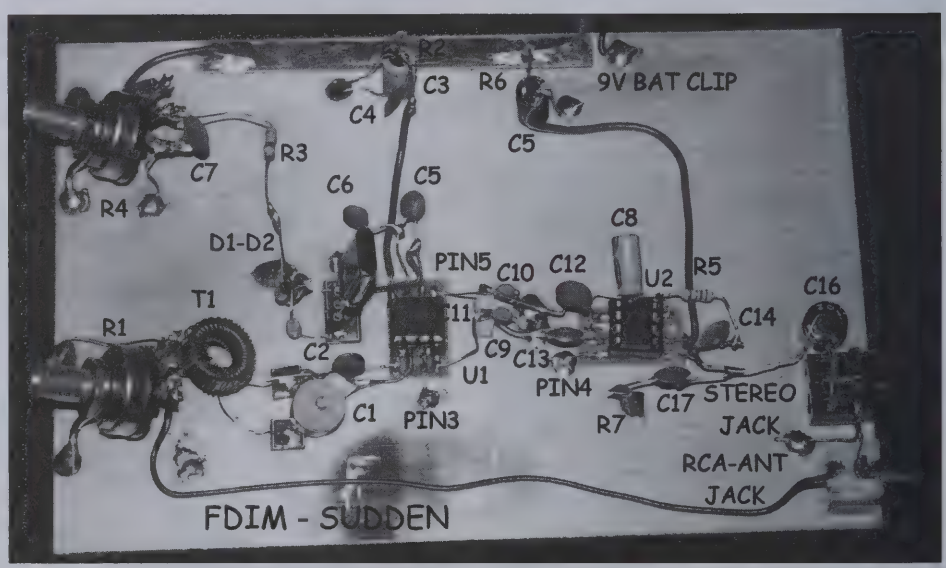



**Figure 2—A completed Sudden receiver.**

As stated earlier, in an attempt to help people gain experience in homebrewing, we focused on the Manhattan style of construction. The project was a direct conversion receiver for 40 meters. It is a version of the Sudden receiver designed by George Dobbs, G3RJV. It uses a VXO (approximately 4 to 5 kHz of coverage) control of an NE602 mixer with audio amplification being provided by an LM386. The schematic is shown in Figure 1. The copper board used was 4 by 6 inches. This size is probably a bit large for the experienced builder, but gives the novice plenty of room to learn. We also saw the advantage of this in that the builder could quickly assemble the Sudden. It also would make it easy to modify when they took it home. (We provided schematics of modifications that they could try at home). We used pads and IC boards provided by QRPme (http://www.qrpme.com/). These helped the inexperienced builder as they came in sheets easily broken into individual pads or IC boards and were pre-tinned making for good solder joints.

A completed Sudden was available at the event so they could see how the parts were laid out on the board. We also provided each builder a picture of the completed unit (see Figure 2). They were told that the easiest way to build via Manhattan is to assemble the parts and lay pads down as needed in the same sequence as the schematic. The exceptions might be controls or jacks, which may be placed for the builder/users comfort when operating. Other exceptions might be whether to place sockets for the ICs or simply solder them directly to the IC board. All of this gave guidance on how to place the parts,



**Figure 3—G3RJV guides a Sudden builder.**



**Figure 4—W1REX provides Elmering to K3SP.**

but we also encouraged them to use their own ideas on component placement. The helpers guided them through the process and encouraged them to experiment with parts placement.

We did have them build the audio section first. Once completed, it was tested and cleared of any trouble before proceeding to the RF section. This gave an early sense of accomplishment and provided confidence to proceed to the RF section. As each builder completed the RF section, a short antenna was put on the receiver and smiles emerged as 40 meter signals came out of the headphones. About half required some troubleshooting; all but one successfully completed a functional receiver.

Few building projects are ever complete. We provided them with take-home schematics of modifications that could be used to increase the VXO coverage and help with front end selectivity.

A few administrative comments and lessons learned include:

- We scheduled 4 hours for the building. It took about 5 1/2 hours to get most people through to completion. So, this could be scheduled as a 1-day event with a lunch break, or two evenings (one for audio, one for RF).
- The first five people to arrive had never used a soldering iron. We quickly set up a station to give them a brief soldering lesson before proceeding to the Sudden. As part of the registration, we asked if they were "experienced" or "inexperienced" builders. They also need to be asked about soldering skills.
- Depending upon the skill level, you may need one helper for each two builders. We had 10 helpers and we were kept very busy.

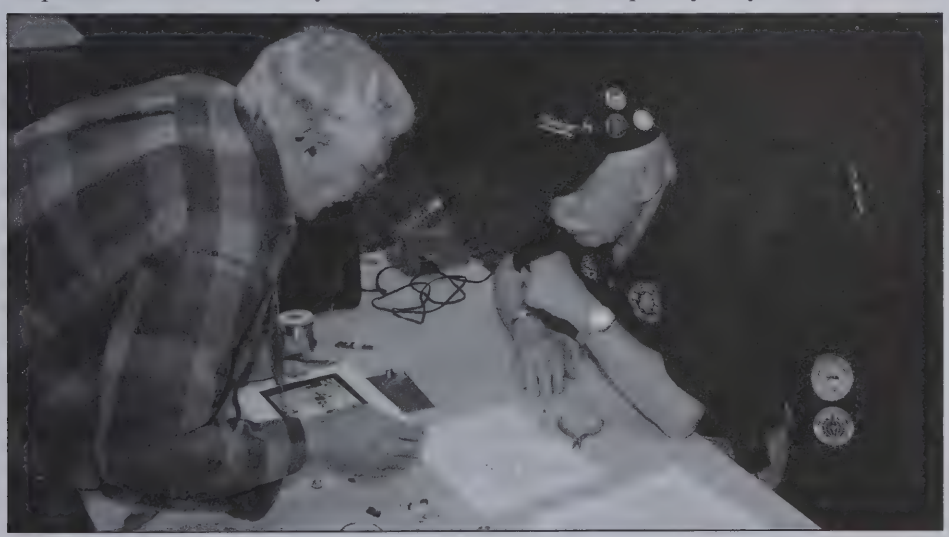


**Figure 5—A serious discussion on parts placement and assembly technique.**

The response to this year's Buildathon was a surprise to us all. We had room for 30 builders, but expected 15 to 20. We squeezed in 32, and we had 8 more on a wait list as we simply didn't have the room. The success rate of completed working receivers was much higher than expected due to the interest level of the builders and the great experience of the helpers. The climate at the end of the project was very upbeat. One helper said it was an uplifting and enriching experience. It was undoubtedly an uplifting experience for the successful new builders *and* all the helpers.

If you think that interest in building has died off in ham radio, this year's buildathon indicates that you may be wrong. In addition, the Ozarkcon event had a Friday night buildathon that was very well attended. The ARRL had a "walk-up" kit building station at the Dayton Hamvention that was kept busy through the hamfest. One of our helpers remarked that when he started out in ham radio, it was a necessity that he build something to get on the air. There wasn't an option to buy something ready made—he had no choice but to build. Today our new hams have choices and can simply go the route of buying a factory made rig. They can choose to build or choose to buy. They may be interested in homebrewing, but not be aware that help is available to guide them though the process. So talk it up at your local club, you may be surprised at the interest in building and homebrewing. Not only that, if you do host a building event, you may have as much fun as the builders. Melt some solder!

# A Portable 80M PSK31 Station

John King—KB3WK kb3wk@arrl.net

This project grew out of a series of experiments that Doug Hart, AA3S, and I conducted a few months back. Our club, the Columbia Amateur Radio Association (CARA), has recently become more involved with ARES/RACES operations. In particular, we regularly train with the county fire department as backup dispatch communicators. While we have been successful in using 2M FM voice radios, it soon became obvious that some type of keyboard communications would be preferable under some circumstances, and that line of sight communications might not be the best approach in some instances. So, we thought about alternate communications means, and came up with the idea of using PSK31 and 80M ground wave propagation.

The next question was "How can we implement a portable station that was not too large, and preferably not too expensive?" That's where the excellent little Warbler kit from Small Wonder Labs [1] came in. The price was right, and the kit could be put together in a single evening.

So, we then tried several experiments, all successful, from the various county fire stations and showed that reliable digital communications could occur with just a few watts and portable antennas that could be erected in less than 30 minutes. Best of all, since the rig consumed only a few watts, a 7 AH gel cell would easily power the radio for an eight hour shift.

There were, however, a couple of short comings in our prototype station. The most significant problem was that the Warbler can easily be driven into non-linear operation if too large an audio input signal is supplied from the laptop used to generate the PSK31 signal. We needed an easy way to determine when the Warbler was putting out its maximum, distortion free power, preferably without carrying around a piece of test equipment. A second problem resulted from the need to control Warbler T/R switching via a serial port connection to the PC, as many new laptops don't have a serial port. There are, of course, USB/serial converters but I wondered if there might not be a better way.

The interface board and antenna described in this article was the resulting solution to these problems. The interface, Warbler kit, and the antenna can easily be constructed for less than $100, thus satisfying the desire for a low cost solution.

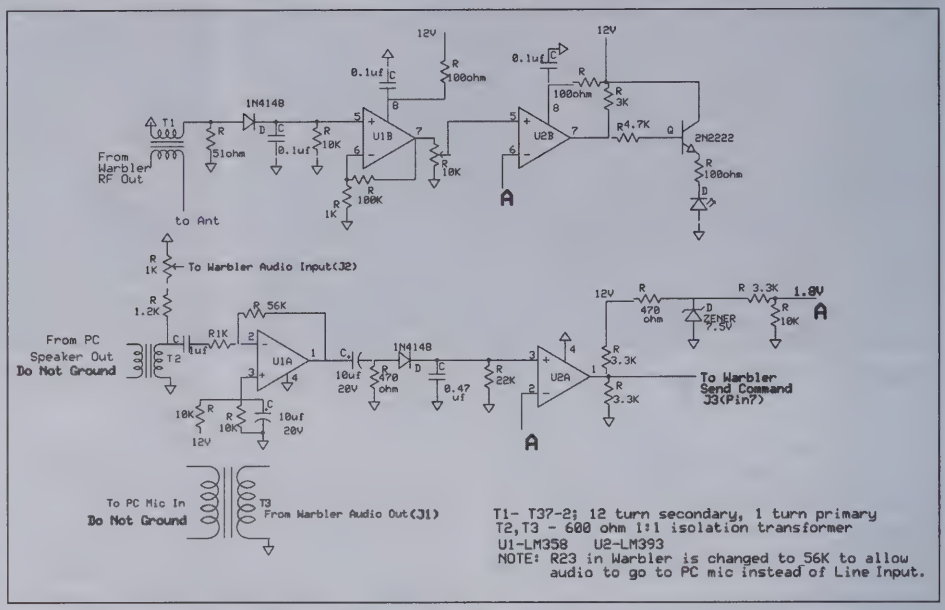



**Figure 1—Schematic diagram for the Warbler interface.**

## Interface Design

Figure 1 shows the schematic for the interface. As the schematic shows, there are basically two separate circuits contained in the interface, and a pair of 1:1 audio isolation transformers used to isolate the Warbler from the PC. Shown in the top half of the diagram is the RF overdrive sensor. The bottom half of the diagram contains the circuitry, which makes the serial port connection unnecessary. All parts are common, low cost devices that resulted in a very inexpensive design. None of the parts are particularly critical, and junk box substitutions will work fine in most instances.

The RF sensor starts with a toroid transformer using a single-turn primary winding to sample transmitter power. When the Warbler is producing its maximum linear output power, the RF sensor should produce a peak-to-peak voltage in the neighborhood of 200 mV. This voltage is then rectified by the 1N4148 diode and fed to U1B, which acts as a DC coupled amplifier. The 10k ohm resistor at the input to U1B is required in order to quickly discharge the capacitor following the diode once RF output has ceased. The output voltage from U1B is then compared against a stable reference voltage in U2B, acting as a threshold comparator. Exceeding the threshold causes the output of U2B to show a high resistance, which forces a saturation current into the 2N2222 and causes the LED to light. The RF power level at which saturation occurs may be set by the potentiometer at the output of U1B. Because the RF sensor can vary somewhat in the amount of output voltage, you may find that voltage at the potentiometer is such that the potentiometer cannot be set to trigger the circuit at a suitable power level. If this occurs, simply change the value of the 100k ohm resistor between pins 6 and 7 of U1B. A higher value will give you greater amplification; lower values will decrease the amount of amplification.

Because both of the ICs used have two identical functions in each chip, we now have an easy fix to the lack-of-serial-port problem. Transmit audio is sampled at the input audio transformer and amplified in U1A. When the Warbler is producing its maximum linear power, this audio signal is about 200 mV peak-to-peak at the input to U1A. The gain of U1A is set so that a fraction of this voltage will produce a 12 V peak-to-peak audio signal at pin 1 of U1A.

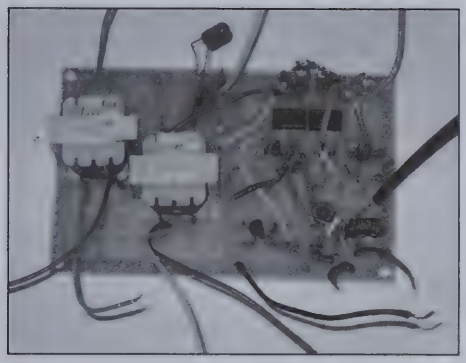


**Figure 2—Prototype interface board.**

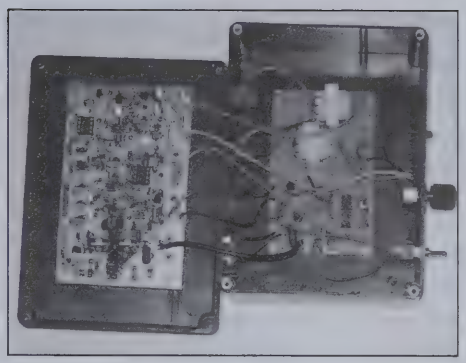


**Figure 3—Interface and Warbler mounted in the box.**




**Figure 4—Front of the completed unit.**




**Figure 5—Rear of the completed unit.**



**Figure 6—Portable 80M vertical.**

In most circumstances, this output signal will show flat topping and may even resemble a square wave. This doesn't hurt functionality, but merely guarantees that a small amount of input audio will trigger the threshold comparator. The output signal from the amplifier is then rectified by the diode and again sent to the comparator. The resistors on either side of the diode are necessary to allow a quick rise and fall of the rectified voltage when audio appears or ceases. Once the threshold voltage is exceeded, the output of the comparator produces an approximate 6 V, similar to RS-232 command voltages. In operation, it appears that audio signals producing enough drive voltage for 150 mW of RF output will reliably trigger the SEND command.

Note also that a potentiometer is used between the output of T2 and the Warbler audio input. This addition was found to be necessary because the slider that controls speaker output level from the laptop PC gives too coarse an adjustment capability for controlling RF power out. So, the slider is used for coarse setting of the audio level, and the potentiometer allows a finer grain setting.

Finally, since this unit will often be used with a laptop PC which typically does not have a line input to the audio card, it was found necessary to reduce the audio output from the Warbler. This is easily done by replacing R23 (2200 ohm) in the Warbler with a 56k ohm resistor.

### Construction Notes

Figure 2 shows the prototype interface board. A "Universal Breadboard" from FAR Circuits [2] was used for this construction, resulting in more discrete wiring than would normally be the case if a custom board had been generated. The RF sensor can be seen in the lower right portion of the figure, just next to the potentiometer used for setting maximum RF output.

Figure 3 shows how the Warbler and interface are mounted in a small plastic utility box. The box should be about 6"W × 2"H × 4"D to accommodate the boards and have sufficient space for the controls and connectors.

Figures 4 and 5 show the front and rear of the completed unit. Since the unit is intended for quick setup in the field, the audio connections in the rear of the unit were color coded to match the red and green colors typically used for microphone and speaker connections on a PC. Audio cables were also marked on each end with corresponding red and green plastic tape, to give a field operator a fighting chance against Murphy. Figure 5 also shows a small dummy load connected to the antenna input jack. The load was constructed by placing a 51 ohm, 2 watt resistor inside a PL-259 plug, and is used in setting up the unit.

### Operation

The unit is very easy to set up in the field. Once connections with the PC and power source are made, output power levels are then set with the dummy load plugged into the antenna connection. Use of the dummy load is required in order to get an accurate setting of the transmit gain control. An SWR higher than 1:1 can result in setting the gain too low. This control is set by first setting it to maximum gain, and then moving the PC audio out slider until the MAX PWR LED is lit. Then, back off the transmit gain control until the light just goes out. Connect the antenna. Set the PC microphone gain so that received signals don't overload the PC audio board and you're done.

### Portable Antenna

Figure 6 shows the portable antenna used for the field experiments. It is con-

structed using a plywood base, which divides into two sections in order to be more transportable, and a tripod roof mount originally intended for outdoor TV antennas. The actual antenna is constructed using five foot sections of lightweight electrical conduit. The bottom section is only four feet long, as it was found that this length made erecting the antenna a bit easier. Sections are joined together using PVC pipe nipples that are friction fitted to one end of the conduit. I found that a 12" double-ended nipple cut in half was about the right length for two section joints. The antenna also uses four 32 foot wire radials laid on the ground during operation.

Because the antenna is only 24 ft. in height overall, it was necessary to load the antenna in order to make it resonant. This is accomplished by placing an inductance between the fourth and final sections at 19 feet. A T130-2 toroid wound with 78 turns of #26 wire was used to provide approximately 100 microhenrys of inductance. Heat shrink tubing surrounding the PVC section joint and inductor holds the inductor in place. Lengths of braid are used to make electrical connection between sections. The braid is permanently connected to one section with a metal screw and uses a clip on the other end to connect with a small metal screw installed in the following section.

This configuration provides a very low SWR at its 3575 kHz center frequency and a 2:1 SWR bandwidth of approximately 35 kHz, which is more than adequate.

A wire version of this antenna has also been constructed, for use where there is an existing support such as a tree. Dimensions are very similar, and it provides approximately the same results.

**References**


1. http://www.smallwonderlabs.com.
2. http://www.farcircuits.net.


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# The QRSS Frontier


Dennis Markell—N1IMW dennis_m_markell@uhc.com


Think operating at 5 watts is tough? Try QRSS on 1 milliWatt! QRSS has something for everyone. You can copy code, work digital interface, engineer and construct a variety of circuits (inexpensively) and join a cadre of enthusiastic amateurs willingly to help you and share a brand new amateur radio experience with you. Join me as we review QRSS theory, explore software options and hear from new operators as they learned the mode of QRSS.

**How QRSS Works**

In reception, the audio output from a station receiver is fed into a computer sound card. When processed by special QRSS software, signals are displayed on the computer monitor. In practice, the computer becomes a very narrow bandwidth filter used to copy code from with the band noise.

QRSS is efficient, but slow. Very slow speed Morse code is used to send a brief message. However, this code is a bit different from the usual on/off keying, in that a dot or dash is sent by frequency shift keying (FSK). One frequency is used to send a dot or dash. At the end of the dot or dash, the carrier shifts to a second frequency just a few Hertz away. The slow speed allows for extremely narrow bandwidth coupled with remarkably low power requirements. Observe ON7YD's table comparing CW speed, bandwidth and relative signal/noise ratio (Table 1).

| Speed | Optimum bandwidth | SNR vs. 12WPM |
|---|---|---|
| 12 WPM | 10 Hz | 0 dB |
| 8 WPM | 6.67 Hz | +1.8 dB |
| 4 WPM | 3.33 Hz | +4.8 dB |
| 1 sec./dot | 1 Hz | +10 dB |
| 3 sec./dot | 0.33 Hz | +14.8 dB |
| 10 sec./dot | 0.1 Hz | +20 dB |

**Table 1.**

| Dot length | Power into antenna | Improvement vs 12WPM CW w/same TX Power | Theoretical value |
|---|---|---|---|
| 0.1 sec. (12 WPM) | 360 mW | 0 dB (reference) | 0 dB (reference) |
| 3 sec. | 23 mW | 12.0 dB | 14.8 dB |
| 10 sec. | 3.9 mW | 19.7 dB | 20.0 dB |
| 60 sec. | 0.6 mW | 27.8 dB | 27.8 dB |

**Table 2.**

A common speed for QRSS beacons is 3 sec/dot. Observe the table bandwidth value for 3 sec/dot the bandwidth: 0.33 Hz. Less than 1 Hertz! View the gain versus sending at 12 wpm: 14.8 dB!

Care to view the attending power requirements? Observe the chart from ON7YD's website outlining G3YXM's transmission to G3NYK (3/2002) (Table 2). The power to realize this gain? 23 mW!!!

**QRSS Software Tools**

While these narrow bandwidth and low power performance metrics are impressive, how does one copy 0.33 Hz? I can barely get my 250 Hz CW filter to clean out the noise… imagine how swamped the 0.33 Hz signal gets!

Enter ARGO. Modern aircraft have fly-by-wire; QRSS has ARGO. ARGO is a software program designed to copy the 0.33 Hz signal sent with just 23 mW that is buried in the noise. You can't hear the signal, but ARGO can show it to you.

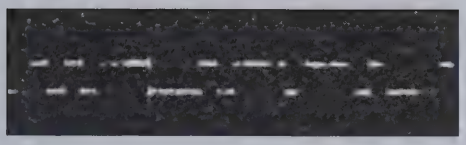


**Figure 1—Sample ARGO display.**

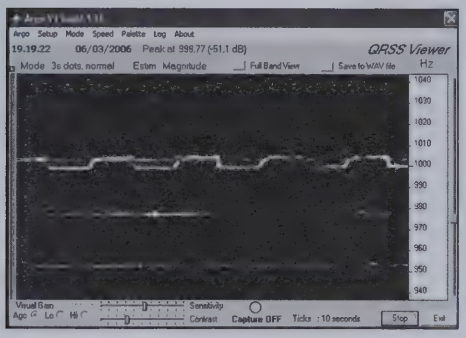



**Figure 2—Full ARGO screen.**

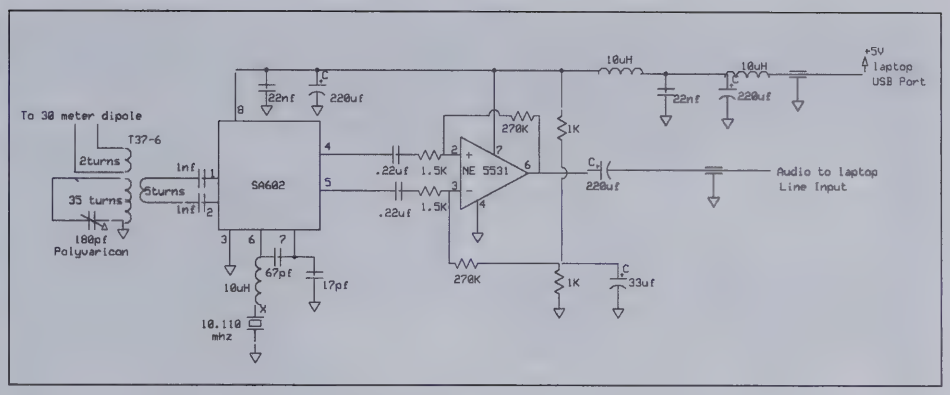



**Figure 3—30 M beacon receiver schematic.**

Similar to the waterfall or curtain displays for popular digital modes, ARGO displays allow QRSS operators to view their signals as well as the surrounding noise while also affording a wide view of other signals in the nearby spectrum. Tailored for weak signal reception, this DSP software works on Windows 95 and up and hails from Italy. A. DiBene (I2PHD) and V. De Tomasi are the authors of this package written expressly for QRSS in the 3 sec/dot and 10 sec/dot speeds. Other popular programs include Spectran, Spectrogram, EasyGram, Spectrumlab, Crunch and QRS. They are all freeware.

Figure 1 is a sample ARGO Display, showing excellent clear copy on Vern, VE1VDM's "grabber" (beacon receiver and display) in Canada. Figure 2 is the full ARGO screen.

**Ready to Build?**

If you enjoy building circuits but spending little, QRSS is for you. A major designer/builder is Hans Summers, GØUPL. Figure 3 is Hans' 30 meter beacon receiver design. Using a toroid matching filter, the signal is fed to an SA602 mixer/oscillator. Balanced output is then fed to the low noise NE5534 op-amp. Op amp output is fed straight to the laptop input port. For a chassis Hans reports: "I purchased a tin of Ozon mints. The mints are small and tasty (70 of them)." The rig has an interesting mount: "The rig sits directly in the centre-point of the dipole. Power rises up from the laptop, audio back down to the laptop via 7 meters of twin screened cable." No feedline issues in this matching system!

**A New Operator's Story**

ARCI member and Carolinian Paul Stroud, AA4XX, is an early adopter of QRSS. "I noticed a web posting from Johan, IN5EX, during the last solar cycle. He was running an experimental transmission and needed signal reports." Remarkably, Paul was able to download ARGO software, learned to operate it with his Argonaut 5 and copied ON5EX's 250 mW signal that evening. "Argo is easy and since the sunspot cycle was strong, copying ON5EX from Belgium was successful."

Following this first QRSS activity, Paul built his own QRSS gear. "I built a keyer from an EEPROM that had variable power and variable code dot length and worked it from my Norcal Sierra rig." Paul went on to work Europe and the southern ionosphere as well, "My most memorable contact was Falkland Islands and then Australia."

Not all of Paul's work was DX. Dave, WØCH, of Kansas became a regular QRSS sked partner with Paul. "Dave and I worked down to one milliwatt and less. We went as slow as QRSS 60. As I recall, we spent 6 hours transmitting the word G-L-U-E."

So, if the low power challenges appeal to you. Grab your iron, explore the many QRSS projects available, and test the skies as our new solar cycle begins!

**Acknowledgements**

All photos, with the exception of Figure 2, are used with the kind permission of Hans Summer, GØUPL. Figure 2 is used with the kind permission of Andrea Borgnino, IWØHK.

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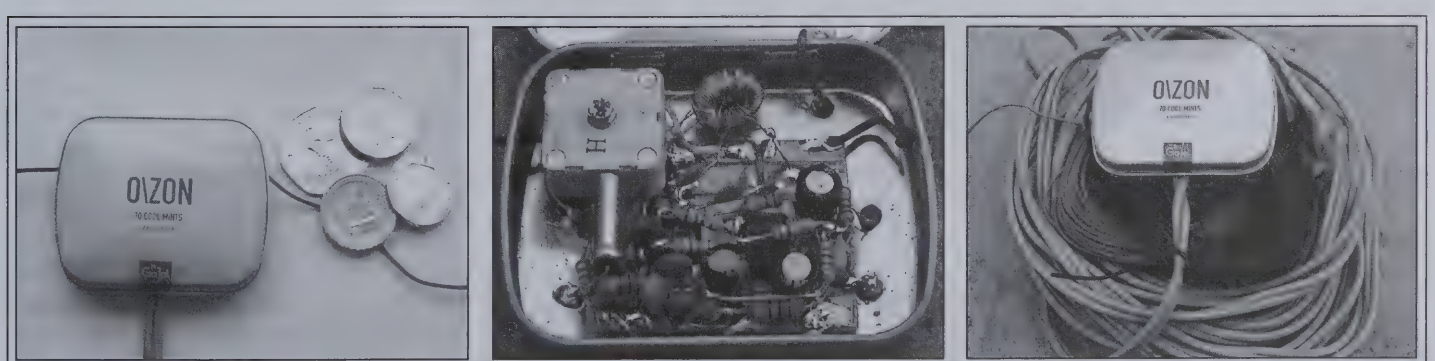



**Figure 4—GØUPL's 30M beacon receiver and antenna: (l) receiver case closeup, (c) receiver case open, (r) receiver and coiled antenna.**

# What is a Trail Friendly Radio for VHF

Bob Witte—KØNR bob@k0nr.com

In the QRP world, there is this notion of a Trail Friendly Radio (TFR), which usually refers to QRP rigs for the HF bands. The basic definition of a TFR usually includes being lightweight and portable, consume low power (battery drain) and be easy to operate in typical "on the trail" situations. OK, on the trail might also mean sitting on the beach or paddling a canoe, but you get the idea. Some hams have emphasized the need for "controls on the top of the radio," but I'll just refer to this as good design for trail operating conditions. A good example of a TFR is the Elecraft KX1.

This got me thinking about the question of what constitutes a TFR for the VHF bands? And does one exist today? I did a little poking around on the internet to see if this issue has been discussed much. Not finding anything, I posed the question on the vhfqrp yahoo group and my twitter feed, and received some good comments back.




**Figure 1—The Yaesu FT-817ND covers the HF, 6 Meters, 2 Meters and 70 cm in one rig.**

### TRF for VHF

Rather than dive into the specific features of a VHF TRF (shortened to VTRF), let's look at how we would apply it first. I imagine using this VTRF for a walk around the park, a day hike in the forest, or an overnight backpacking trip. Obviously, I'd want it to be independent of AC power, compact and easy to carry. I'd want to be able to work all modes on 50 MHz, 144 MHz and 432 MHz, the most popular VHF (and one UHF) bands. CW and SSB are important for serious weak-signal work on all three bands and sporadic-e openings on 6 Meters. There is nothing more fun than catching a good 6 Meter opening during the summer months out "on the trail." Although much less efficient, having FM provides access to the largest number of VHF radio operators. And, yes, of course I want to be able to work those FM repeaters when wandering in the back country. Adding to the wish list, I'll include some of the fancy extras common to typical handheld FM transceivers: weather radio receive, FM broadcast receive and extended coverage receiver for fire/police/forest service/ etc. These features let me keep tabs on the weather and listen in on public service agencies such as park rangers and fire departments.

I had several people mention to me that APRS is a great thing to have on the trail. People commented that they can hitch an HT (such as the Kenwood TH-D7AG) with a small GPS receiver to create a compact position reporting station. I tend to carry a GPS with me when doing VTRF activity anyway, so coupling it to the VTRF makes some sense.

This is a tough set of requirements but, what the heck, it never hurts to dream big!

### Practical Choices

Let's bring this down to reality by looking at some practical choices for a VTRF. The first radio that comes to mind for many folks is the Yaesu FT-817, since it is the only commercially available rig that is relatively compact, portable and has CW/SSB/FM on the three bands of interest. It has the added benefit of covering the HF bands as well. (I understand that some people still work those bands, even with the sunspot drought.) Unfortunately, the FT-817 does have a significant flaw—it is a battery hog. The FT-817ND manual lists the receive (standby) current as 250 mA (squelched) and 450 mA (unsquelched). Compare this to say, an Elecraft KX-1 with a receive current of 34 mA (typical). This is a real problem for extended portable operation. A less significant shortcoming of the FT-817 is that the extended receive frequency coverage on the 2 Meter band stops at 154 MHz, missing the U.S. weather radio band at 162 MHz.




**Figure 2—The ICOM IC-P7A is an example of a "mini-HT" with dualband (2M and 70 cm) capability.**

Next on our list of potential VTFRs is the good old FM handheld transceiver (see "My QRP Rig is an HT," *QRP Quarterly*, Summer 2008). Of course, the HT falls short on the ability to do CW and SSB. It does excel in the compact and portable

category as it is hard to beat how an HT slips onto your belt or into a pocket.

There is a class of mini-HTs that includes the Yaesu VX-3R and the ICOM IC-P7A, which are extremely compact and easy to carry. Both of these radios have a rich feature set and extended coverage receive (from the AM broadcast band all the way up through UHF). While they are compact in size, they still pack the features in. These little radios are a shirt-pocket ham shack.

As mentioned previously, having an APRS transmitter in your equipment is a handy way to bleep out position information and other messages. The classic handheld radio for APRS is the Kenwood TH-D7AG, which has been recently discontinued. Yaesu recently introduced the VX-8R, which has an optional GPS receiver that results in an all-in-one-unit APRS station. This rig is full-featured, with a hefty 5 watts of RF output power.

QRPers like to build kits, even for the VHF bands. Rick KK7B recently introduced some VHF kits that are of interest to us. The RCX2 is a receive converter for the 2 Meter band that translates down to 7 MHz, for use with your favorite 40 Meter QRP transceiver, including the KK7B microR2. The RCX1-6 converter is the same basic kit but receives the 6 Meter band. For transmit, KK7B also has kits for two CW sources for 2 Meters and 6 Meters, with an output power of 10 mW. The KK7B kits fall short of my ideal VTFR but are a fun way to get on the air with a rig that you have built yourself.

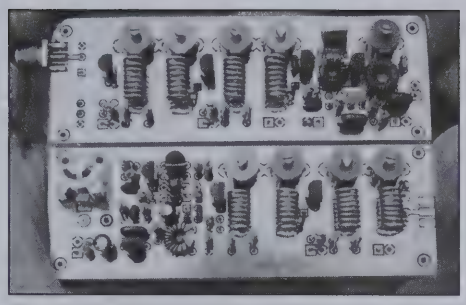


**Figure 3. The KK7B RCX2 receive converter for 2 Meters.**

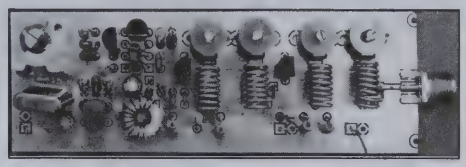


**Figure 4—The KK7B 2 Meter CW source.**



**Figure 5—Some telescoping BNC antennas.**

### Antennas

Every radio needs an antenna, so what kind of antennas will we use for our VTFR? The FT-817 comes standard with a large "rubber duck" antenna, that works better than you might expect. But still, it is limited in size and gain, so there are a number of longer telescoping BNC antennas available (Figure 5). These antennas will work well when moving on the trail and setting up temporarily. We might want something more if we stop for the night. For 6 Meters, we can use the standard dipole, cut to resonate on 50 MHz. For the 2 Meter and 70 cm bands, a small Yagi might be the way to go (Figure 6).

### Sum It Up

By my definition, there really isn't an excellent VTRF available today. The FT-817 comes quite close, except for the battery drain issue. Maybe we just have to overlook that. (Several people suggested that we should just get over it and accept having to carry a larger battery.) I don't suppose that Yaesu is too worried about the battery issue, since the FT-817 is unmatched in the marketplace. I wonder if one of the manufacturers might start sneaking in some basic CW and SSB capability into their handheld radios? It is technically possible but the market may not drive them to do it. Mizuho (and others) used to have SSB handhelds for both HF and VHF bands, but they are no longer made. In the meantime, we can always take advantage of the VHF kits and build our own VTFR.

Faced with such a dilemma, what do I really do? My first choice for casual hiking, day trips and backpacking is the HT. The heavier the pack, the more carefully I consider the weight of the radio. But for real radio fun, I take my FT-817....and a big battery.

What is your VTFR? Drop me a note at bob@k0nr.com or stop by the blog at www.k0nr.com/blog.

*73, Bob, KØNR*

### References


1. Garmin Foretrex http://wa8lmf.net/ForeTrex/index.htm.

2. VHF QRP Yahoo Group: http://groups.yahoo.com/group/vhfqrp/




**Figure 6—The Arrow II antenna is a yagi that works on 2 Meters and 70 cm.**

# QRP Clubhouse

Timothy A. Stabler—WB9NLZ wb9nlz@yahoo.com

Well, here it is, another quarter of the year gone, and I am still not in my new place. I am told it now will now be less than a month, but we will see. I hope so, as I had everything packed last summer, and I want to build something. Who doesn't? I do not have much this time and hope to hear from some of you about your groups. By the way, I have heard that there will be a QRP convention in Massachusetts next year. Registration does not begin for a few months, so I expect to have more information in my next two columns.

Also coming up is CactusCon 2009, sponsored by the Arizona ScQRPions. Their Web site is: http://www.azscqrpions.org/Cactus Con2009.htm. The dates for CactusCon 2009 are July 31st and August 1st.

I had an e-mail from Chris Waldrup about trying a new frontier and that is QRP-light beam communications. They are using 3 watt LEDs as their "transmitting antenna" and BPW34 photodiodes as their "receiving antennas." They modulate the LEDs with an 800 Hz tone using a PIC microcontroller driving a MOSFET. The receiving end is a photodiode connected to a high gain low noise amplifier, which is fed into a laptop and processed either by using Spectran or Spectrum Lab. Some of the transmitters and receivers are mounted in boxes with large Fresnel lenses on them. So far they have had success in copying a signal from about 5 miles away but are limited in their area by lots of large trees. So, they have been operating over a large man-made lake. They are planning a trip to the NC mountains in an effort to get longer shots. The people so far involved include Rye Gewatt, K9LCJ; Gary Onell, N3GO; John Marshall, KU4AF; and Chris Waldrup, KD4PBJ.

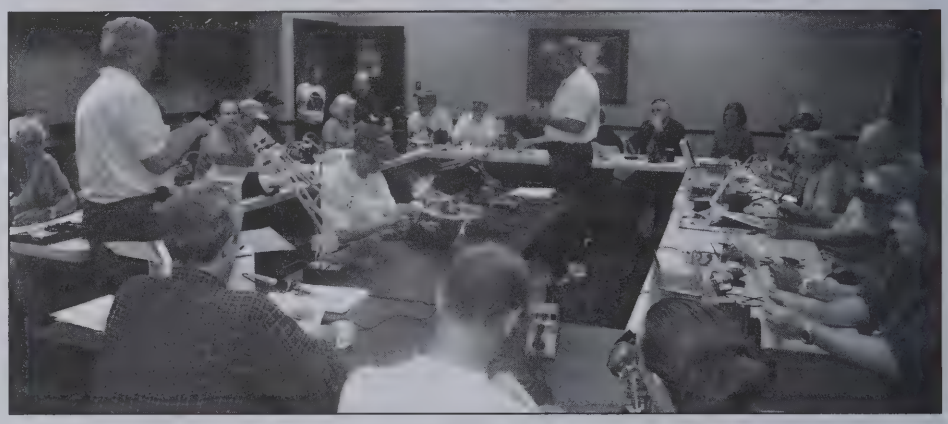
Chris went on to say that his wife has finished her Ph.D. at the University of NC and has accepted a job at Frostburg State University in Frostburg, MD. So, they will be moving Northward this summer. Chris has found no evidence of a QRP group in the area (Tri State area of MD/PA/WV) but would like to start a QRP group like the Knightlites that is informal with no dues or officers. He hopes to get some interest in such a group and has found at least one other QRPer in the area while looking for a house. There could be a group like this in the area. Myself, I really do not know. If you want to help start this group, or know of a group like this in the area, please let Chris know by email at: kb4pbj@bellsouth.net.



**Early birds in the vendor area.**



**Friday night dinner at the hotel dining room.**



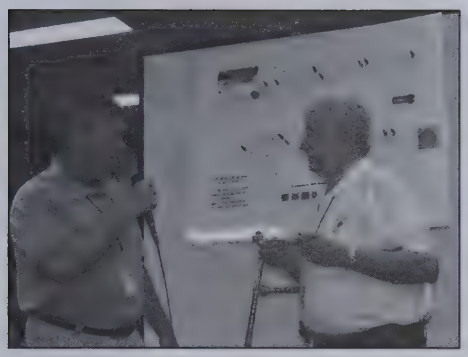
**Dar and Darrel with their first group of signal injector builders.**

**Ozarkcon 2009**

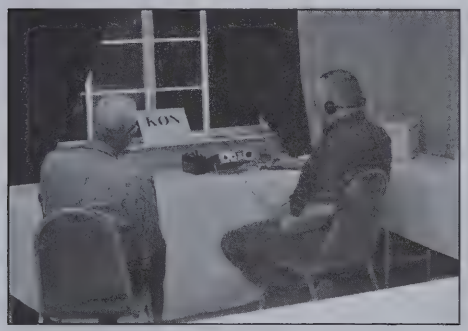
This year, Ozarkcon was moved from Joplin, MO to Branson, MO. This was a good move, especially for families. The hotel offered attendees to allow increasing their length of stay a couple of extra days at the Ozarkcon rate, if desired. Honestly, this is a great convention and one full of things to do and great talks. The 4 State QRP group does an excellent job setting this meeting up and are to be commended for their outstanding job well done. The group paid for Ozarkcon in part by selling the little audio amp described in the sidebar.

Friday night was the banquet. It had been a serve yourself type of event, but this year we were served by waitresses. The meal was excellent (prime rib) and we had some talks from a tour person from Branson and a lady from the Titanic museum they have there. Following the banquet, we went back to the part of the hotel where we held the meeting to have the kit building sessions, some contests and room for the vendors to set up. The meeting was held at the Stone Castle Hotel which is actually three buildings. We were in the third building and the dining room was in the middle building.

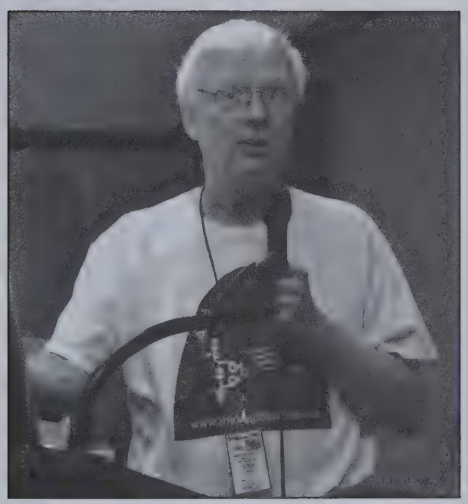
The kit of the evening was a signal injector/tracer sponsored by the Homebrewers QRP group in Ashland, Nebraska. Doug Hendricks, KI6DS, made the kits available. Dar Piatt, W9HZC, and Darrel Swenson, KØAWB, were in charge of both sessions where most people finished their project. Also, that evening was the Wacky Key Contest and the dummy load QSO party. At the end of the evening,



**Dar and Darrel giving their talk the night before on using the signal injector.**



**Station KØN working FDIM attendees using their rigs and dummy load antennas.**



**Phil talks about ultrasound transmissions.**

people got out their guitars, banjos, or whatever, and we had our evening music session.

The meeting talks began Saturday at 9:45 A.M. with comments from Doug Hendricks, KI6DS, who has been the master of ceremonies for some time. Everyone likes Doug and he had some time to introduce the people who did the work setting the meeting up, etc.

## Sidebar—Four State QRP Group: Enhanced Manhattan Islander Audio Amplifier

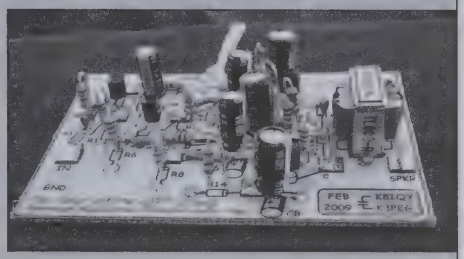
With OzarkCon 2009 looming on the horizon, the Four State QRP Group found itself needing funds to underwrite the conference, and this was to be accomplished without incurring debt. The very successful NS-40 Class E transmitter by David Cripe, NMØS, helped us immensely along the road to solvency, but additional income was needed.

While searching for projects to kit, I asked Jim Kortge, K8IQY, if he had any designs that we might use. True to his supportive nature, Jim thought that the NJQRP Islander Audio amp would make a good kit since it had been retired for several years. He also suggested gaining approval from the NJQRP Club, who originally kitted the design in 2001, and Paul Harden, NA5N, whose artwork graced the original manual. So with the consent of NJQRP's George Heron, N2APB, Paul and I began to contemplate the kit.

Three variations on the original came to mind. I had built one of the NJQRP kits in 2005 with a JFET preamp (circuit by Jim), so I wanted a preamp in this one. Manhattan construction was desirable, and that caused me to think of the beautiful Enhanced Manhattan© artwork and building methodology of Larry Przyborowski, K3PEG. If Jim would add the preamp and Larry would develop templates, I thought we would have a winner, and it turns out that was a prophetic thought. Kit sales have been great, ensuring that OzarkCon 2009 would happen.

Jim agreed to work up the changes, and in the process tweaked the design for increased performance over the original circuit. Larry graciously took on the task of creating his special pad layout templates, and in the process he also created very artistic assembly instructions. The end result is a small, powerful, quiet, easy to build speaker amp which matches up nicely with your earphone CW rig. Because of the excellence of the instructions and pad layout templates, this kit is an ideal introduction to the Manhattan building process.

The original design has been enhanced with an added preamp and the original circuit improved by Jim Kortge, K8IQY, who was the designer of the original kit and manual. Additionally, Larry Przyborowski, K3PEG, enhanced the board design with his wonderful Enhanced Manhattan template/layout designs. He also developed the outstanding assembly manual. Larry is well-known for his Enhanced Manhattan work on K8IQY's 2N2/40+ and 2N2/20 transceiver designs. Larry's builds won 1st and 2nd prize at two Atlanticon building contests.



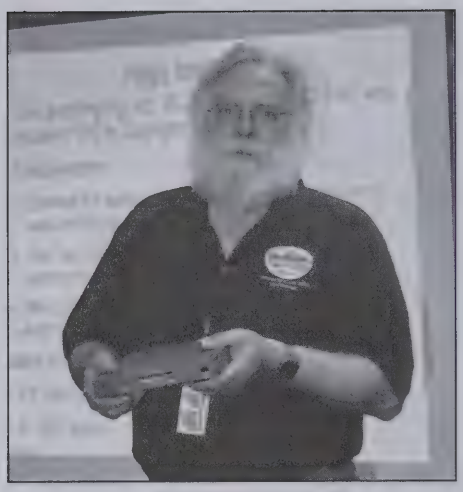
The kit features all Manhattan pad construction utilizing 3/16" square pads, no islands to cut, no drill press needed, all pads—easy construction. This amp has a very quiet noise floor, a well-known K8IQY circuit trait. You have to hold the speaker to your ear to know that it's powered up. Even then, the background hiss is barely detectable. I call it "spooky quiet."

It features 65 dB power gain, small 2" × 3" board, all Manhattan construction, and is Altoids® compatible! It can be driven to about 150mw output into an 8 ohm speaker, with clean audio and room filling volume. The pass band response curve shows a broad peak at approximately 500-1000 Hz. Of interest is that Jim innovatively placed a capacitor across the primary of the output transformer to resonate with it's inductance to produce that response. The input impedance is 100K for superior isolation and light loading of preceding audio stages.

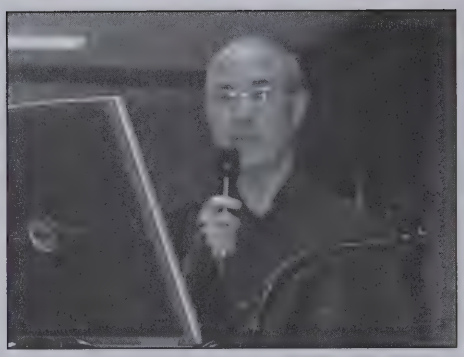
All documentation, including the original NJQRP manual, is included in the kit on a mini CD. It is very complete with K3PEG's Enhanced Manhattan templates, detailed step-by-step instructions to build it either Enhanced or regular Manhattan style, actual size templates, and many excellent pictures. The kit includes all components, documentation, and associated parts to build the amplifier complete, less connectors and enclosure.

If you're interested in a great building experience resulting in an inexpensive and excellent speaker amp, the Enhanced Manhattan Islander Audio Amp from Four State is for you. The kit sells for $20 which includes first class postage in the US, DX orders are $23 and quantity discounts are available for clubs and group builds.

Much more information is available on the kit's web site, http://www.wa0itp.com/emislander.html.



**Jim, Dr. Megacycle, talks about QRP.**



**Jim Kortge speaks about the evolution of his famous 2N2222 transceiver.**



**EzNDil do their musical thing Saturday night.**



**Folks at Ozarkcon in between talks.**



**The music group Saturday night when everything else was over.**

The first speakers were Dar Piatt, W9HZC, and Darrel Swenson, KØAWB, talking about how to use the kit built the night before. They had a board with a circuit drawn out on it, with the components underneath. They had gotten this board from Dr. M. Holburn, G3XZP. They then went through the circuit showing if they got a tone, that part of the circuit was okay but not okay if there was no tone. I had not built the kit with all my building materials packed up but I did find the talk very interesting and learned something I really did not know about that well. They showed that you can test circuits with no power applied. The only problem was that they wanted to show something and the circuit board fell to the floor and something got shorted out. So the rest of their talk was about how to do this kind of testing.

The next speaker was Phil Anderson, WØXI, talking about an ultrasonic transceiver for 35-45 kHz. He played some tapes of his listening to bats, about 100 feet away, and insects in the lawn. By using two transceivers, one can send Morse code to a second station about 50-100 feet away. His recordings of their "conversations" were very interesting. A piezo transducer is used, giving about a 15-20 degree spread. In looking at the received signal (40 kHz) the signal travels about 340 m/sec. At this writing, the transceiver (Ultra-Mite) is not yet available from Midnight Science (www.midnightscience.com) but the transceiver has been in beta testing and Phil hopes to have the kit available by the time you read this. If you are not interested in a transceiver at this wavelength, ultrasonic receivers (Ultra-RX1) are available. You can get some good information on ultrasound by going to the Midnight Science Web site.

Following the lunch break, which gave everyone time to eat as well as look over material offered by vendors, the next talk was given by Jim Duffy, KK6MC, on VHF and UHF QRP work. As you might know, Jim is also known as "Dr. Megacycle." For the last two years, this area has been of great interest to Jim. He went over several different models of radios and transverters that can be used. He then centered on propagation. He thought the Yagi was a better directional antenna for this type work. He has built an aluminum U-tube for mobile work. He mentioned that feedline loss was significant for VHF work. Some nice drawings for Yagis are found at WA5VJB.

The last talk was given by Jim Kortge, K8IQY. He brought everyone up to date on his famous 2N2222 transceiver. It has now been around for 12 years and was offered by NorCal as a kit for 10 years. In 1998, Jim won the home-built contest at Dayton for this rig. He has made some circuit

changes to fit the 30 meter band and the 20 meter band. All three have been basically built on the same circuit board with modifications on components used for band changes. The kit turned out to be difficult for NorCal, as there were over 300 parts for the kit. The documentation for Jim's original 40-meter rig is available on Jim's Web site (www.k8iqy.com). There is also information on other rigs that this circuit has inspired.

At the end of each talk, a board certificate is awarded to the speaker. Then it is time to give out several door prizes that have been offered by vendors and individuals. At the end of all talks, this is the time that the grand prize is awarded. This year, there were two grand prizes. The first name drawn was Joe Eisenberg, KØNEB. He was offered his pick of either the Weber Dual Bander from Hendricks QRP kits or the Hendricks PFR3 transceiver (www.qrpkits.com). He chose the PFR3 transceiver. The next name drawn was Darrel Swenson, KØAWB. He got the Weber Dual Bander.

After dinner, Doug Hendricks brought in an act that used to be at the Silver Dollar in Branson but are now tending a farm in Taneyville, MO. The act was called EznDil, and they do a music-humor act. Their real names are Michael Micham and Nancee Walker-Micham, and they did a first rate job. I have never heard a guitar, a four string banjo or pennywhistle played as well. A CD of their music was available. After the act, they joined our late night musical session. If you want more information on them, please see their Web site at: www.frontdoorfarmmarket.com.

Well, that is about it for now. I do hope to hear from some of you about your clubs and/or groups. Let me know what your clubs are doing so I can let everybody else know.

Take care, now.

*72, Timothy Stabler, WB9NLZ*

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# QRP World News

Oleg Borodin—RV3GM RV3GM@mail.ru

**United QRP Clubs—To be!**

My dream becomes true! I was here! I was at FDIM! Thanks to all who helped me visit the greatest QRP event! I met a lot of my old friends and got many new ones. Moreover, that was my first travel outside Russia. I am a happy man. I will not describe all the details of the great QRP symposium or other events. Other authors make it better because my English is not so well for it, sorry. I would only like to say about two of the greatest news.

After some discussions with Councils of the largest QRP Organizations of the World (QRP-ARCI and G-QRP Club) we have come to a decision:

1. To organize a United QRP Clubs—analogue of the World UN. The membership in UQC must be free for any QRP Clubs of the World. Details of this project are in construction for now.
2. To organize the World QRP Contest. The Rules of WQC analogical by CQ WW contests with little variations.

Coordinator of this project is open for any suggestions for both projects accordingly. I welcome any ideas to the address below! Thanks in advance!

P.O. Box 229
Lipetsk, 398043, Russia
E-mail: rv3gm@mail.ru

*72! From Oleg (Mr 72), RV3GM*

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**To health of United QRP Clubs!**



**Long live United QRP Clubs!**

# Class E Power Amplifiers for QRP

David Cripe—NMØS

A Class-E power amplifier is an RF switching power amplifier capable of nearly 100% DC-to-RF conversion efficiency. These are simple, robust circuits which are worth considering of inclusion within QRP transmitters. This presentation covers the theory of operation, a practical, cookbook approach to design, and comparison with more conventional Class-B power amplifiers.

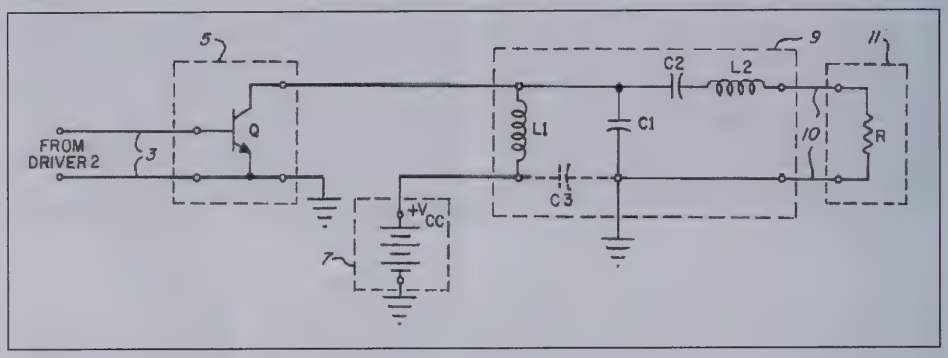



**Figure 1—Basic Class-E circuit (1).**

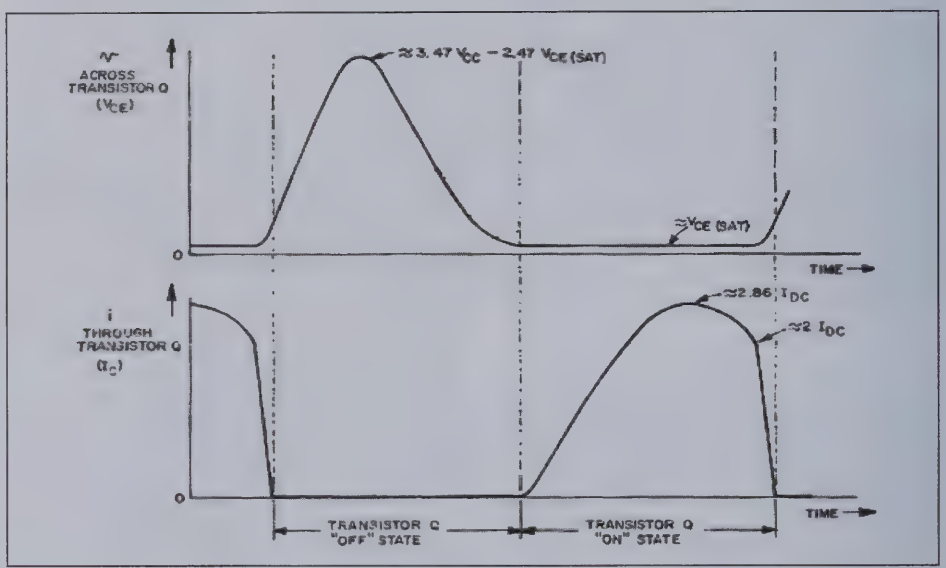



**Figure 2—Characteristic Class-E waveforms (1).**

## Introduction

Much of the appeal of the QRP hobby lays in the simplicity and economy of the QRP radio equipment. The popular "Pixie" and "Tuna Tin" kits, for example, have exemplified this concept of reducing amateur communication equipment to a minimal state. Both concepts of simplicity and economy are part of a larger notion of efficiency. Efficiency of design yields a simple radio, with few, and inexpensive components. Efficiency of power allows the fewest watts to effectively provide communication from one station to another. To take full advantage of the low-power aspect of the QRP hobby, attention should also be paid to maximizing the electrical efficiency of the output amplifier.

The majority of amateur radio transmitters have been designed with final power amplifiers set up to operate in Class-B or AB, which typically yield DC to RF efficiencies of at most 50 or 60%, and often well below that. Even a good Class-C amplifier, optimized for CW operation, is hard pressed to reach 80% efficiency. In contrast, by utilizing a final power amplifier operating in Class-E, it is easily possible to obtain DC-to-RF efficiency exceeding 90%.

The term "Class-E" may not be familiar to most hams, but it is a technology that has been around for over thirty years. It is a type of switching power amplifier invented in the mid 1970s by Nathan Sokal, WA1HQC and his son Alan Sokal [1]. It has gradually come to achieve widespread application, and is today used in areas ranging from broadcast transmitters, to cell phones, RF induction heating equipment, and others.

There have been relatively few amateur radio products or projects that have taken advantage of the benefits Class-E power amplifiers have to offer. Perhaps the most well-known amateur radio product utilizing a Class-E power amplifier was the SGC "Mini-Lini," a cigar-box sized, 500-watt class-E amplifier [2]. One ham who has done much toward popularizing Class-E circuitry is Steve Cloutier WA1QIX, through his website www.classeradio.com [3]. Most of the designs published on his site are elaborate multi-hundred watt QRO transmitters, which might not hold much appeal to the QRP enthusiast. The benefits of Class-E power amplifiers are not only limited to high-power applications. The author's NS-40 transmitter [4] is a 5 watt, 40 meter Class-E transmitter, one of few QRP Class-E products currently available.

The purpose of this presentation will be to describe simple, low-powered circuits that can exploit the advantages of Class-E power amplifiers for the QRP enthusiast.

## The Class-E Power Amplifier

At first glance the Class-E power amplifier circuit, shown in Figure 1, does not appear to be significantly different from other more-familiar classes of RF power amplifier. It contains a transistor, tuned output circuit, and output harmonic filtering, just as does a Class-B or -C power amplifier. The distinction in the Class-E circuit lies in the specific values of the inductors, capacitors, and load impedance surrounding the transistor, and the specific transistor voltage and current waveforms it produces, allowing it to operate most efficiently.

Sokal [1] defines a Class-E power

amplifier as possessing waveforms with the following characteristics:

* Saturated transistor conduction occurring over 180 degrees of the RF cycle.
* A resonant waveform at the transistor drain during the interval of transistor non-conduction, that swings to zero volts immediately prior to the commencement of transistor conduction.
* Drain current that begins at zero amperes during the half-cycle of transistor conduction.
* A drain waveform with a zero voltage-rate-of-change immediately prior to the commencement of transistor conduction.

These conditions are fulfilled by a circuit that generates the specific set of waveforms that are unique to Class-E power amplifiers, which are depicted in Figure 2. For this reason, it is common to tune and optimize a Class-E power amp by observing its drain waveform on a high-speed oscilloscope, which can be compared to the ideal waveforms. By observing the specific manner in which the sample waveforms depart from the ideal, it is possible to determine the specific circuit components that must be adjusted.

Unlike a linear power amplifier such as Class-B, the output power of switching power amplifier classes such as Class-E is relatively unaffected by amplitude of the drive signal. Instead, if the output power of Class-E amplifiers is to be controlled, it is done so by varying the supply voltage.

**Efficiency**

The power dissipated in a given power amplifier device is the product of voltage across it, and current passing through it, integrated over an RF cycle. A switch is capable of controlling passage of electrical power very efficiently as it acts either as a very small resistance, or a very large one. In its "off" state, a switch supports voltage while allowing no current flow. In its "on" state, a switch permits current flow through a low resistance. The power loss in the switch in either the "on" or "off" conditions are minimized. If the power amplifier active device behaves as a switch it has the potential to convert power at near 100% efficiency.

One loss mechanism associated with switching circuits in general is the result of the discharge of any capacitance associated with the switch at the beginning of its conduction cycle. The energy stored in this capacitance C, when charged to voltage V, is $1/2 \times V^2 \times C$. If this capacitor is charged and discharged through the switch at frequency F, the power loss in the switch will be $1/2 \times V^2 \times C \times F$. Consequently, it is essential that the voltage across the switch and its capacitance be zero at the commencement of switch conduction.

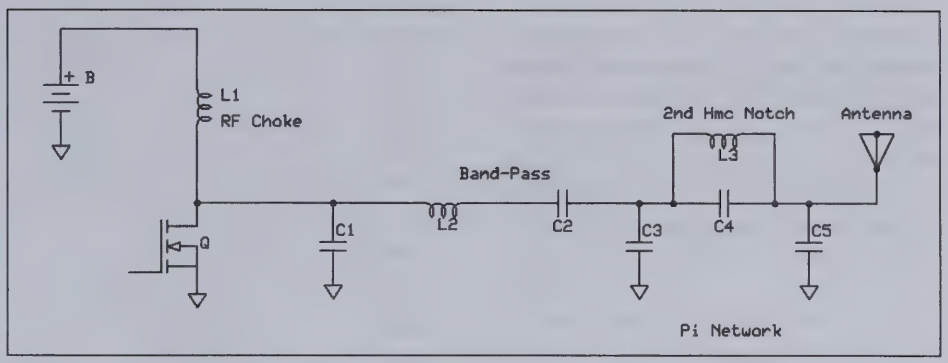



**Figure 3—Practical Class-E power amplifier.**

Since the active device in a Class-E power amplifier is utilized as a switch, its conduction losses are minimized. The characteristic drain voltage waveform allows zero-voltage switching, which contributes to its efficiency by the reduction of switching losses.

It is not difficult to design Class-E power amplifiers for HF with efficiency surpassing 90%. Per watt of output, a Class-E transmitter will have one-third to one-fifth the transistor dissipation as one using the same amplifier transistor operating in Class-B or Class-C. The implication of this is that the Class-E power amplifier will use less power, run cooler and more reliably, and can be constructed with fewer or smaller output transistors. The results of this are simpler, more economical transmitter circuits which are ideally suited for QRP. For a battery-powered station, the 40% reduction in power consumption-per-watt of transmitted power translates to a significant improvement in battery life.

**Design of Class-E Power Amplifiers**

It is relatively easy to design a Class-E PA if a cookbook approach is followed. Sokal published the essential relationships to determine component values for a given frequency, power, and input voltage in his original patent and his comprehensive *QEX* article (6). Simplified equations can suffice, though, for typical cases, with sufficient accuracy for the hobbyist.

Figure 3 depicts a practical QRP transmitter circuit, a modification of Sokal's basic circuit to include an additional circuit at the output for impedance transformation and improved harmonic attenuation. To determine the component values of the circuit, the desired power output P is defined, and the power supply voltage, B, is selected.

The power amplifier MOSFET can be chosen next based on the power output and supply voltage. Bear in mind that in a Class-E power amplifier, the peak drain voltage swings to 3.5 times that of the supply voltage, and higher when operating into non-unity VSWR. For a transmitter operated from a 12 or 13.6 volt power supply, a 60 volt-rated part is adequate if VSWR is kept below 2:1. A MOSFET rated to 100 volts Vds operating from 13.6 VDC will not likely experience VSWR-related voltage breakdown.

There are two readily available, inexpensive MOSFETs that will serve the majority of 12-volt QRP applications. The first is the 2N7000, a plastic TO-92 part, with 2 ohms Rds, and 20 pF Coss output capacitance. The second is the IRF510, a TO-220 with 0.54 ohms Rds, and 81 pF Coss output capacitance. The 2N7000 will serve well up to 1 watt output. A two watt transmitter can be constructed of two, paralleled 2N7000s. The IRF510 will serve well at two to ten watts output. Both parts will work well up to 21 MHz.

Another MOSFET worth considering in QRP service is the 2N6661. It is a MOSFET with similar ratings to a 2N7000, but with an upgraded 90 volt drain breakdown voltage rating, housed in a TO-39 package. Because this metal can package can be

effectively heat-sunk, this part will be preferable to the 2N7000 where high reliability is required. These benefits are somewhat offset by its higher price tag, in the $3 range.

Once the desired output power P has been selected, the load resistance R for the PA can be calculated from the formula:

$$R = 0.32 \times B^2 / P - 1.5 \times Rds$$

For purposes of example, let us design a 5 watt PA, operating from 13.6 volts, for 40 meters. This would require a load resistance of 11.0 ohms.

Then the total PA shunt capacitance C1 is determined. This value includes the intrinsic Coss capacitance of the MOSFET. This is given by the formula:

$$C1 = 0.19 / (2 \pi \times F \times R)$$

Our 5 watt, 40 meter PA would then require 385 pF of total drain capacitance. When using an IRF510, which has a Coss (drain-source) capacitance of 81 pF, this yields a value for C1 of 304 pF. We may use two, 150 pF capacitors paralleled. In practice, the physical layout of the circuit requires that this capacitance must be mounted as close as possible to the body of the MOSFET—even directly bridging the drain and source leads, if possible. Excessive inductance between the MOSFET and this capacitor will ring during device switching, leading possible loss of device efficiency or instability.

The series L2 - C2 network between the MOSFET drain serves to attenuate the drain waveform harmonics, and pass a largely sinusoidal current. The value of the capacitor C2 should yield a reactance with a magnitude somewhere between one to two times that of the load resistance R, preferably selected to be a common standard value of capacitor. For our sample circuit, we select C2 to equal 1000 pF.

The series L2 - C2 network has a further requirement that its net reactance have an inductive component with a magnitude equal to 1.8 × R. This means that the value of L2 is determined by the formula:

$$L2 = [1.8 \times R + 1 / (2 \pi \times F \times C2)] / (2 \pi \times F)$$

For our sample circuit, L2 will be 0.94 μH.

From here, it is necessary to match the load impedance R of the power amplifier to 50 ohms. While transformers are the most frequently used solution, if the load impedance R of the PA is between about 10 and 250 ohms, the easiest way to perform an impedance transformation is with a Pi network. This is comprised of C3, C5, and L3. Capacitor C4 parallels L3 to resonate at the second harmonic of the operating frequency, providing the extra attenuation required to meet FCC limits on harmonic emission.

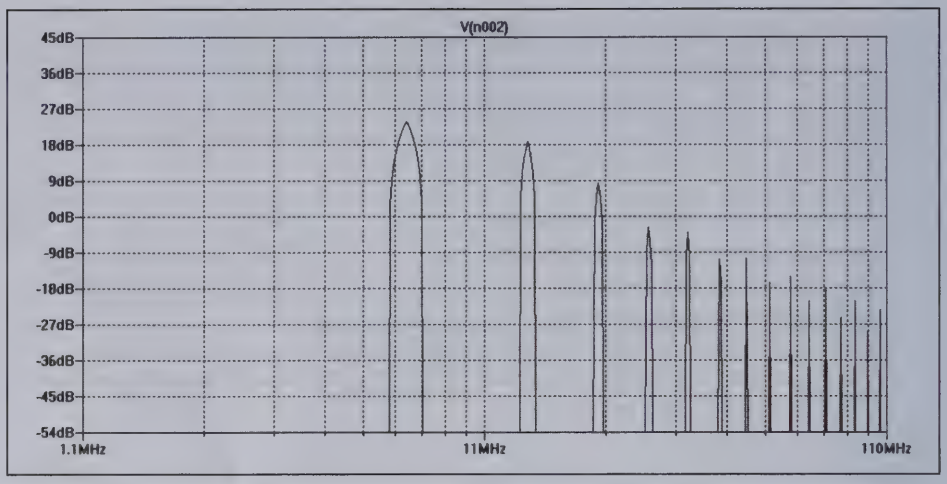



**Figure 4—Harmonic content of the Class-E drain waveform**

The value of C3 and C5 are given by:

$$C3 = C5 = 1 / (2 \pi \times F \times (R \times 50)0.5)$$

This yields a value for C3 and C5 of 950 pF. This may be approximated by paralleling two 470 pF capacitors.

The value of L3 is given by

$$L3 = 0.75 \times (R \times 50)0.5 / (2 \pi \times F \times R)$$

This gives a value of 0.38 μH for L3.

The value of C4 is given by:

$$C4 = C3 / 3$$

This gives a value of C4 as 317 pF. We may use a 100 pF capacitor paralleled with a 220 pF.

Finally, the value of L1 is chosen so that its impedance is high compared to the load resistance. It should be greater than ten times the value of L2, and capable of handling the DC current draw of the power amplifier without saturation.

Wherever possible, the values for C1, C2 and L2 should be within 10% of the ideal values, while C3, C4, C5 and L3 should be within 5%. Pay attention to the current rating of the components during their selection process. Generally, use of silver mica capacitors throughout the output network will prove adequate. RF- or microwave-rated chip capacitors are also preferred. Check the manufacturers' data sheets for current ratings during the design process.

As the inductors L2 and L3 are non-standard values, these should be wound on iron-powder toroids, and the turns spacing adjusted as necessary to attain the desired values. The power output may be fine-tuned to some degree by adjusting L2.

Once these component values have been determined, they may be used to create a simulation to verify the circuit power output, tuning, and efficiency. Analytic tools such as PSPICE and similar circuit simulation programs have taken much of the cut-and-try iteration out of PA design. One excellent freeware circuit simulation program is SWCAD III, available for download from www.linear.com [5]. Intended for use in design and optimization of switch-mode power supply circuitry, this software includes electrical models for many common MOSFETs and bipolar transistors familiar to the QRP community. Incremental changes to the components in the power amplifier may be made to bring the output power and drain waveform shape closer to design goal.

### Harmonics and Output Filtering

All power amplifiers possess some degree of non-linearity which results in

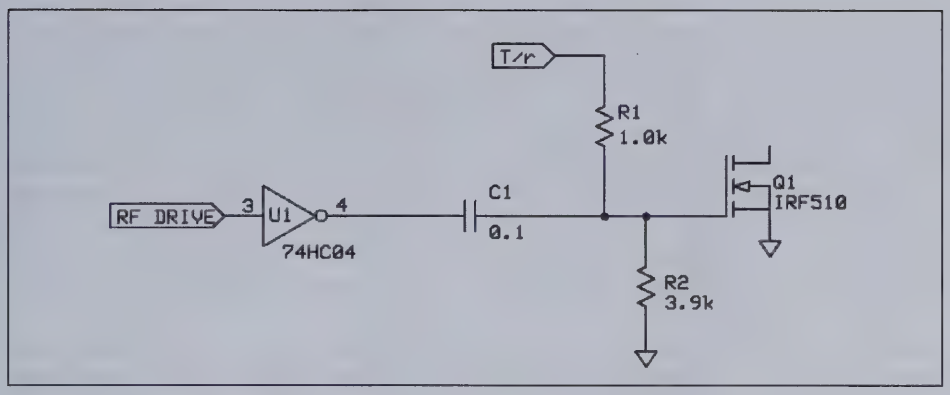



**Figure 5—Drive circuit for Class-E PA.**

some degree of harmonic generation in the process of amplifying a sinusoidal carrier wave. The Class-E drain waveform, being non-sinusoidal, contains a high harmonic content, depicted in Figure 4. Operating courtesy demands that out-of-spectrum emissions be limited, while FCC specifies all harmonics are to be –45 dB with respect to the carrier. Examining the spectral plot, it is apparent that the second harmonic, at –6 dBc, is closest in both frequency and amplitude to the carrier, so is most difficult to attenuate.

Generally, the most effective approach is to add a second harmonic notch in the output filter of the transmitter, and in a circuit with a minimum number of inductors, can be formed by adding a capacitor in parallel with the choke in the output Pi network. The output network described in the cookbook design circuit of Figure 3, consisting of a series L-C bandpass, followed by a Pi-lowpass network with a second harmonic notch will attenuate harmonics sufficiently to meet the FCC requirements. In the absence of a spectrum analyzer, an estimate of the harmonic output of the transmitter can easily done by modeling the entire amplifier using the Fast-Fourier Transform capability of SWCAD III.

### Thermal Considerations

The primary failure mode for MOSFETs operating in a switching mode is from excessive temperature at the semiconductor junction. The worst-case effect of operating a Class-E power amplifier into a poorly-matched antenna impedance is a decrease of efficiency leading to increased heat dissipation in the MOSFET. To be reliable, the power amplifier must be designed to maintain its transistor at a safe temperature.

A very conservative rule of thumb for reliable amplifier design is to keep the semiconductor die to below 100 degrees C. Although most MOSFETs are rated for operation at temperatures up to 150 or 175 degrees C, the "on" resistance of most MOSFETs will increase 60% between 25 and 100 degrees C. A Class-E power amp operating at 90% efficiency at room temperature will see its efficiency reduced to roughly 84% if the transistor reaches 100 degrees.

It is possible to calculate the temperature rise of the device knowing the heat dissipation, the thermal resistance of the power device, published in that manufacturer's data sheet, and that of the heat sink used, if any. The thermal resistance of the 2N7000 in its plastic TO-92 package is 312 degrees C-per-watt. Allowable heat dissipation for this part would be around 0.25 watts. The thermal resistance of the IRF510 in its TO-220 package, without a heat sink, is 62 degrees C per watt, safely allowing over a watt of dissipation.

Addition of a heat sink to a TO-220 can reduce the total thermal resistance of the part significantly. The common, folded aluminum sink of the type sold at Radio Shack will reduce the thermal resistance of a TO-220 transistor to about 20 degrees C per watt, further increasing its allowable heat dissipation.

### Drive Requirements

As a MOSFET is a voltage-controlled device, driving a Class-E power amplifier is a matter of applying enough RF voltage to the MOSFET gate to drive the device fully into saturation. What complicates this it that the gate driver circuit must charge and discharge the large MOSFET gate-source capacitance with each RF cycle. The upper frequency at which a particular driver circuit may be used will be inversely proportional to the product of driver output impedance and the MOSFET gate capacitance. There quite a number of commercial ICs intended for driving large MOSFETs in switching power applications, most of which do not function well at HF.

Fortunately, there is a simple solution that lends itself well to this application. Common 74HC-family logic gates can supply sufficient current to function effectively in this application. A single 74HC gate can directly drive a single 2N7000 at up to 14 MHz, or two paralleled 2N7000 MOSFETs at up to 7 MHz. Alternately, two paralleled 74HC gates can be used to drive a single IRF510 at up to 7 MHz, and so on. Another less common logic family is the 74AC family which has approximately one-third of the output impedance of the 74HC family. Although not available from every parts supplier, they are worthy of consideration.

While a zero-to-five volt logic signal is usually adequate to drive most MOSFETs, there is an additional trick that can further improve the effectiveness of the digital logic gate as a drive amplifier. Since the turn-on threshold of most MOSFETs is in the 3 to 4 volt range, the MOSFET can be driven harder into conduction by shifting the 0-to-5 output voltage of the logic gate upward by 1.5 volts to provide a 1.5-to-6.5 volt swing. This can be done by capacitively coupling the output of the logic gate to the gate of the MOSFET, and then resistively biasing the MOSFET gate up to 4 volts. Figure 5 depicts a circuit that serves this function. The "T/r" input signal is a TTL-level signal that goes to 5 volts during CW transmission, providing this bias to the MOSFET gate. By switching this bias voltage at the beginning of each CW element, and back down just prior to its end, the CW element can be shaped to soften the rise and fall times, reducing spectrum bandwidth of the transmitted signal.

### Comparison with Class-B Power Amplifier

With our power amplifier designed, it is worthwhile to compare it with a Class-B power amplifier also using the IRF510 MOSFET, at the same power output. With a circuit simulation program such as

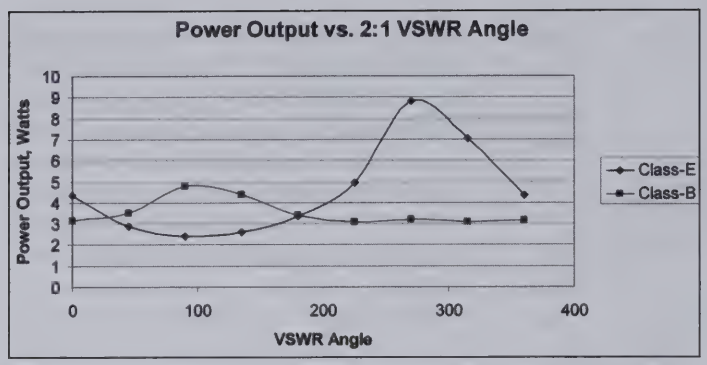



**Figure 6—Power output of Class-B and E PA at 2:1 VSWR.**

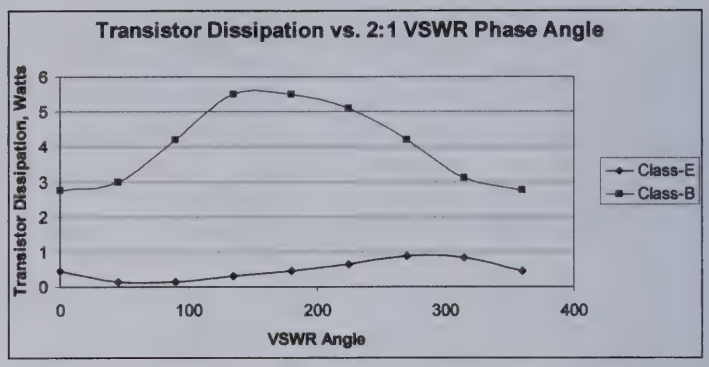



**Figure 7—Transistor dissipation of Class-B and Class-E PAs at 2:1 VSWR.**

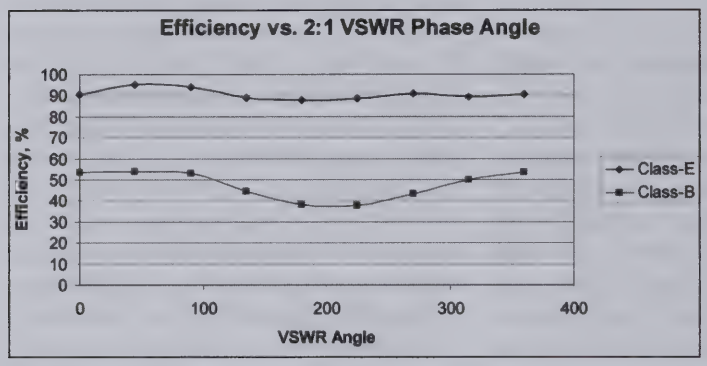



**Figure 8—Efficiency of Class-B and Class-E PAs at 2:1 VSWR.**

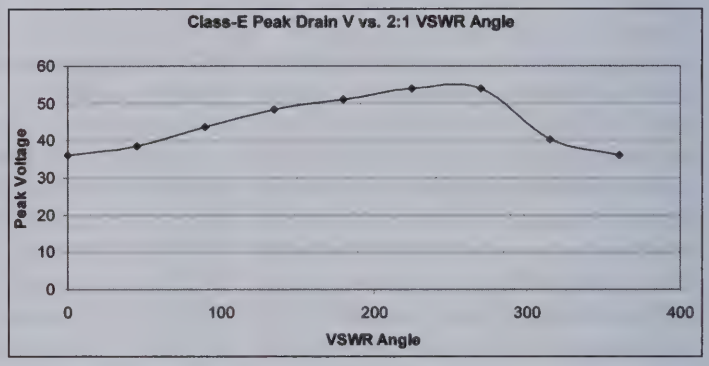



**Figure 9—Peak drain voltage for Class-E PA, 13.6V input.**

SWCAD III, it is easy to perform a head-to-head comparison quickly, and obtain quantitative data for evaluation of their respective merits.

A sample Class-B circuit was designed for comparison with a Class-E circuit. As with the sample design produced from the cookbook equations, which also used an IRF510, and delivered 5 watts from 13.6 volts. It used a resonant drain circuit with a Q of 5 to generate a sinusoidal output waveform, and to attenuate output harmonics.

Although both circuits are set up to deliver equal output power, the most significant difference between the two circuits was the power dissipated in the MOSFET. The MOSFET in the Class-E power amplifier dissipates 0.34 watts. The Class-B power amplifier transistor, in contrast, dissipates 3.4 watts. This significant different in the transistor dissipation between the two circuits results in higher efficiency, cooler junction temperatures, reduced heat sink size, and improved reliability of the Class-E power amplifier.

It is also worth examining the performance of the two power amplifier circuits when operating into non-ideal loads. The load impedances of the SWCAD III circuits were modified to present 2:1 VSWRs, and varied at 45 degree intervals around the Smith chart VSWR circle. The resulting variations in output power of the Class-B and -E circuits are plotted in Figure 6. It is notable that the power varies more significantly with load changes with the Class-E circuit than with the Class-B circuit. As the Class-E power amplifier can be considered a low-impedance RF voltage source, its output current will vary inversely with the load resistance. The Class-B circuit, on the other hand, exhibits less variation under load mismatch, as its drain current is largely defined by the gate drive voltage.

Next, an examination of transistor dissipation as a function of phase angle under 2:1 VSWR conditions is performed. The results are compiled in Figure 7. Within the 2:1 VSWR circle, the transistor dissipation of the Class-B amplifier varies from a low of 2.8 watts to a high of 5.5 watts. In contrast, the Class-E power amplifier transistor has transistor dissipation that ranges between a low of 0.15 w and a high of 0.87 w for all 2:1 VSWR loads. It can be seen that for 2:1 VSWR, the worst case transistor dissipation for the Class-E PA is still well less than the best case dissipation for the Class-B power amplifier, and at all times the Class-B dissipation is at least four times higher than that of the Class-E transistor dissipation.

The roughly three-fold increase in transistor dissipation that the Class-E MOSFET experiences at worst-case 2:1 VSWR conditions should be taken into account by the designer. While the junction temperature of a non-heatsunk IRF510 will remain below 100 degrees C at this dissipation, a heat sink should be added if it is anticipated that more challenging antenna impedances might be presented.

A comparison of DC-to-RF conversion efficiencies of the Class-B and -E power amplifiers is plotted in Figure 8. Despite the varying VSWR angles, the efficiency of the Class-E power amplifier remains near 90%, while the Class-B power amplifier efficiency varies from 38 to 55 percent.

The designer of the QRP transmitter should take into account the effect that non-unity VSWR can have on the peak drain voltage of the MOSFET. Figure 9 depicts the peak MOSFET drain-source

voltage occurring on a Class-E amplifier operating from 13.6 volts, over all 2:1 VSWR angles. Normally, the peak voltage will be approximately 46 volts, 3.4 times the supply voltage. The worst-case peak voltage at 2:1 VSWR will be 54 volts. While this is a safe voltage for a 100 volt-rated IRF510, this is close to the 60 volt rating of the 2N7000.

**Further Topics**

It is possible to modify the Class-E power amplifier to operate in a push-pull mode. The benefit of this is that the second harmonic is largely canceled, eliminating the need for a second harmonic notch in the output filter. Additionally, the value of the drain choke L1 may be reduced by a factor of four compared to that of the single-switch circuit. Design equations for a push-pull amplifier are contained in reference [7].

As noted previously, the Class-E power amplifier can not by itself be used to linearly amplify an RF signal. They can and do find frequent application in amplitude-modulated transmitters. The Class-E ham transmitters described at the WA1QIX's www.classeradio.com website use switch-mode, Class-S modulators to provide an audio-modulated voltage supply to produce an AM signal. To utilize a Class-E power amplifier to amplify SSB signals, a technique of Envelope-Elimination-and-Restoration (EER) is used. Invented by Leonard Kahn [8], EER is a technique where a switching power amplifier us used to amplify the instantaneous phase information contained in the SSB signal. A separate audio-frequency amplifier is used to amplify the envelope waveform, which is then supplied to the RF power amplifier as a modulated drain voltage supply. The SSB waveform is recreated by the multiplicative action that takes place in the switching power amplifier. With the technique of EER, it is possible to amplify a complex, SSB signal at high efficiency, usually exceeding 80%. The SGC Mini-Lini [2] "linear" amplifier utilized EER in conjunction with a Class-E RF power amplifier.

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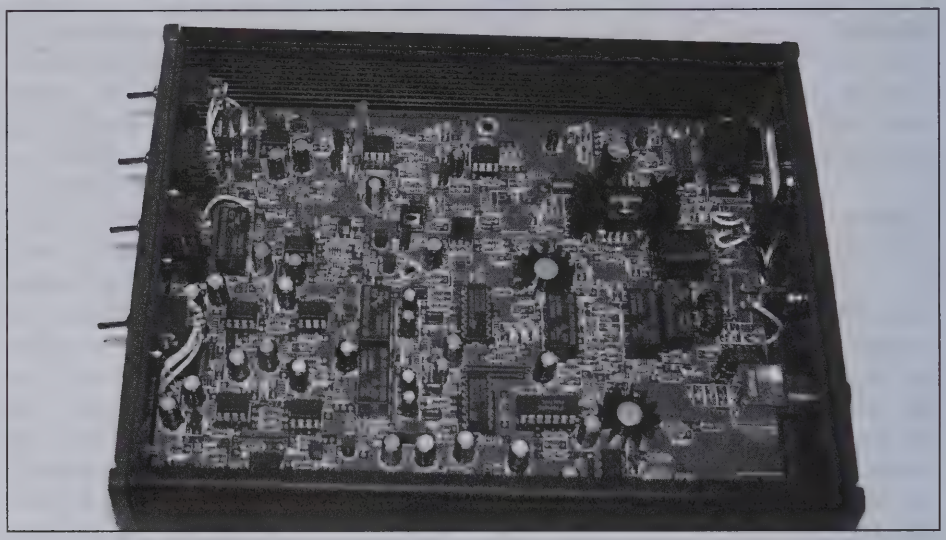
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# Product Review: Genesis G40 Software Defined Radio

Chuck Nolin—WA6LTV WA6LTV@comcast.net

Software defined radios (SDRs) are becoming yet another interest group in amateur radio. They provide the opportunity to improve on the general performance or add features to a radio without purchasing new hardware or making hardware modifications. Many of us have heard of the Soft Rock and Flex Radio products, but a company in Australia caught my eye. It is Genesis Radio who currently offers a transceiver kit called the "Genesis G40." It is an all mode 5-watt kit for 40-meter transceiver, selling for approximately $150 (US). An enclosure for the board must be purchased separately.



**Genesis Posted Specs**

• Frequency range: 7000-7095 kHz utilizing sound card with 96 kHz sampling rate. A sound card with sampling rate of 192 kHz would extend the frequency range to 6953-7140 kHz. Further, the frequency range can be extended to 5-7.7 MHz with external LO.

• Receiver sensitivity for S/N = 10dB and bandwidth 500 Hz is between –118 to –120 dBm without RF preamplifier or from –128 to –133 dBm with RF preamplifier. The receiver sensitivity of Genesis G40 is sound card dependent—a high quality sound card is strongly recommended!

• Receiver input IP3in is >30 dBm

• SFDR: Spurious free dynamic range without intermodulation is between 94 to 98 dB with two signals separate from 5 to 20 kHz.

• Receiver 1dB compression point is +15 dBm with turn on attenuator or –2 dBm and –27 dBm without attenuator and additional RF preamplifier gain position +23 and +46 dB .

• Receiver opposite side band /audio image rejection: 45 dB minimum with built in hardware and more than 70 dB with software correction

• Transmitting mode: SSB/CW/FM/DIGITAL or any other modulation generated mode with quadrature I/Q modulation signals, determined by software.

• RF output power: 5W

• Local oscillator rejection is min. 60 dBc.

• Transmitter opposite side band audio image rejection with built in hardware is minimum 45 dB. With software correction it is possible to adjust image rejection to more than 70 dB.

• Power supply requirement: +13.8V / 100-250 mA on receiving and 1.7A on transmitting.

• Software: Genesis G40 is tested with following freeware transmitting software: PowerSDR SR40, PowerSDR-IQ, M0KGK and Rocky with one or two sound cards.

• Minimum PC configuration required: P4 1 GHz with 128 Mb RAM and SDR-suitable sound card. List of recommended SDR sound cards is offered.

• Genesis G40 KIT parts are classic through hole components (not SMT). PCB dimensions: 150 × 195 mm

Additional Information can be found at www.genesisradio.com.au/G40/index.html.

As I sit here at the operating bench, I am enjoying the wonderful sounds emanating from my computer speaker system. They are originating from my recently completed Genesis G40 SDR all mode transceiver. It is designed by the talented Tasic' Sinisa. Tasa YU1LM has a wonderful Web site (http://yu1lm.qrpradio.com) all about SDR. I am fairly new to this rapidly growing new wave of ham radio. An SDR is basically a direct conversion radio, performing RF to audio conversion and providing I and Q outputs. But thanks to the advent of computing power, the sound cards take the I and Q audio and do the very rapid conversion from audio to digital signal. The software then does the job of processing the digital information to a very high level so you get good SSB, digital or CW. In this article, I am just going to pass along my experience with acquiring and building my new G40 radio.

First off, I have been interested in the new wave in ham radio. New radios are coming available almost monthly. I found this new radio advertised and went to the web site and checked out the specs. WOW what an incredibly complete radio. By that I mean when you complete the circuit board you can plug your cables and are good to go, communicating with over 5 watts output. At 13.8v input to the radio, the current draw when transmitting will be around 1.3A. At the full 5+ watts output, the IRF510 final with its large heat sink was carefully designed to handle the +60 to 80° C heat of the average daily ham contacts. If you decide to run a contest, you will need to add a little more cooling for the final. Replacing the stock 25 mm heat sink with a 37 mm copper heat sink will handle the contest environment.

After going over the Web site, I decided to give it a try. Now this isn't just your ordinary across town kit producer; the kit is assembled in Australia. The fine gentleman providing the kit is Nick. So I shot the funds off to Nick, by way of Pay Pal. I got my bench ready and settled in for a long wait. I was very nervous about ordering from half way around the world, but my new G40 kit arrived to my house in

Atlanta, Ga. in less than one week. That's great service.

So I got my assembly manual together and started to look over my new build. I did a quick inventory of my kit. Nick has the kit divided up in into seven build phases. It is advised to not jump around as with each phase you are going to perform a system function check on the section you have built. If there are any discrepancies in the voltage and resistance checks you can troubleshoot the section you have just built. That way, you aren't overwhelmed by the complexity of trying to troubleshoot a complete radio and not knowing what section works or not.

I did notice that there are a few spots to be aware of when inserting the parts. Pay close attention to putting the part leads in the correct hole, as there are holes next to and before the hole that should be used. So just take your time.

There are just under 400 parts in this build, but they are all through-hole components and Nick has provided good part overlays to help in the part location. One other thing that has caused some confusion is the jumper wires that are to be installed in certain locations. These *Must Be Installed* at the correct points of the build or you won't get the correct readings at the conclusion of the phase build.

IC sockets are not provided and some questions have been raised regarding the use of IC sockets. If you use them, use high quality sockets. I used gold plated machined pin. You will use a bunch of them.

Nick provides a good pictorial assembly manual. As of this writing, with the blessing of Genesis Radio, Robby, WB5RVZ, is putting together one of his magnificent online assembly manuals. If anyone has built a Softrock, then you have probably used one of his assembly manuals.

After you have opened each bag and sorted the parts, it only takes a short while to complete each phase. You will then proceed to checking out that build. All of the specs are listed at the end of each phase. I found I had a little trouble with the jumpers that are to be installed at certain points, I thought I followed the build manual exactly but my voltages were wrong. I had left off a jumper that was in phase 7. I never saw it but in the end I just installed all jumpers and all was ok. In the build, there are only 3 coils to wind—two standard toroids and one stacked transformer. Nick is available for questions and he responds very quickly. He is a highly trained, experienced watchmaker by trade.

When you get to the end, you will down load your choice of control software. I chose PowerSDR. I am still learning about this software. Christos Nikolaou, SV1EIA, is the ham that refined this software for our use. It is a modified version of the Flex Radio software. Christos is available, and answers emails rapidly to help answer your questions. Check out the Powersdr-iq group on Yahoo Groups. This is a very helpful place to get even more information on the PowerSDR control software. It is free to download.

Nick has a pictorial page to follow exactly how to set up your Power SDR software. I just followed it and found all to work exactly as advertised.

At one point along this SDR road, I tried to use a very expensive Creative Sound Blaster sound card with this radio. Christos has worked extensively trying to get this card to work well with SDR. It just won't cooperate at all. After many exhaustive emails back and forth, Christos said to purchase the Edirol FA-66. It is a fireWire, external sound card. I purchased one and now I have a great sounding radio. This is the card recommended by Flexradio for their SDR-1000. So the point is, start with a known good card in the first place. The sound card is the heart of this new radio craze. This is where the majority of the conversion takes place. This is an ever changing field and it is good to research it when you are ready for your sound card.

I then agonized over the enclosure to put it in. I chose the TEKAL 42.29 extruded aluminum enclosure, purchased from Teko Enclosures. It arrived here in just a couple days. Great service! Take your time and you'll be rewarded with an enclosure you'll be happy to show off. I am still working on my panel label.

Well, how does it sound on the air? Wonderful, the audio is very stable and quiet. You don't get fatigue from having to listen to all of that band noise. The radio has attenuators and preamps built in. Just a flip of a switch and configure the radio in one of many available options to adjust the audio to the strength and band conditions at your location.

Mine puts out about 8 watts into my Barker Williamson folded Dipole.

Using PowerSDR, it is such a joy to see all of the signals on the band at a quick glance. You just click on the signal you want and instantly your station is there filling your room with those magical sounds.

It is an all mode transceiver, but I haven't explored them yet. I have set up the software for SSB and it sounds good. It also performs well in the digital modes. In addition, PowerSDR combines with the G40 and provides a second receiver option—great for chasing DX or contesting.

I hope you get yours and enjoy the relaxing build. Watch the Web site for the new models that are in process of being developed. Soon to be released is a G20-30, a 20 and 30 meter radio. Also, an all band transceiver is in the planning stages. Sounds like we will have some more great radios to build very soon.

*Chuck*

●●

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BRAEBURN #4103 CHILE

# Antennas 101: Test Signals for Your R-X Bridge

Breed—K9AY

k9ay@k9ay.com

Over the years, I have bought and built several impedance bridges for antenna and circuit measurements. Some of my past columns described bridge design, calibration and use (see References). Now it's time to discuss the rest of the system—the signal source and detector.

Acurate measurements can be made with a simple bridge circuit [1-3]. This type of bridge operates by comparing the unknown impedance with calibrated resistance and reactance dials. However, the bridge is only part of the measuring system. A signal source and a null detector are also required (Figure 1). The impedance measurement is made by adjusting the dials until there is complete cancellation of the test signal (a null). At this point, the calibrated instrument dials indicate an impedance that is identical to the unknown impedance, showing us its value.




**Figure 1—A simple R-X bridge like this requires a signal source and a detector, since the measurement is made by adjusting the dials for a null.**

### The Detector

The detector for a bridge is easy—any receiver that covers the operating frequency can be used. The receiver will need a BFO if your signal source is CW. Of course, your ham receiver has this capability and is probably the simplest choice.

### Signal Source Options

There are many ways to create a test signal for R-X bridge measurements. A signal generator instrument can be used in the lab, but portable measurements might be problem. Building a tunable oscillator with a wide frequency range will work, but it is not a simple homebrew project. A VFO with a more modest range might be a good choice for your favorite band. DDS VFO kits offered by several vendors are a good option for a compact signal generator, but they will add to the cost, and generally require substantial power supply current that may limit battery lifetime.

For many years,"noise bridge" designs have been published that use a wide bandwidth noise source as the test signal. A diode or transistor junction creates the noise, which is then passed through several stages of amplification. These noise sources are convenient, but insufficient ENR (excess noise ratio) above ambient noise can make it difficult to hear the exact point of the null.

For lab or shack measurements, I use my spectrum analyzer and tracking generator as the signal source and detector, but for portable measurements, my preferred option is a portable receiver and a comb generator (commonly called a marker generator).

### A Simple HF Comb Generator

The comb generator I designed creates an S-9+ signal every 25 kHz from low frequencies to well beyond 30 MHz. The diagram is shown in Figure 2. All parts are readily available at Digi-Key and Mouser. Total cost is just a few dollars.

A 4060 IC (U1) combines oscillator and frequency divider functions. An under-a-dollar 400 kHz ceramic resonator is the frequency determining device (X1), adjusted to frequency with a variable capacitor. Ceramic resonators are not precision devices, so the coupling capacitor values might need changing for different brand resonators, or even different manufacturing lots.

A 25 kHz square wave is obtained at the divide-by-16 output (pin 7). This square wave goes to a 74HC4000 quad 2-input NAND gate, which acts as a pulse-shortener. The square wave is fed simultaneously to an input of one gate (U2b) and to a series of three gates (U2d,c,b) wired as inverters. The output of this 3-gate chain—an inverted and delayed version of the input—is the second input to U1a. The above sequence of events is diagrammed in Figure 3. As you can see, a short pulse is created with a width equal to the propagation delay through the three inverter stages. For the IC I used, this is about 12.5 ns, which results in a "first zero" at about 80 MHz [4]. The spectrum of the output signal is shown in Figure 4. (You engineering types might recognize this as a sin*x*/*x* amplitude response). A photo of my perf-board version of the comb generator is shown in Figure 5.

The output level is quite high, since the IC output pulses approach 5 volts peak. The energy is spread out over a couple thousand individual frequencies 25 kHz apart, but is still enough to reach approx. S-9 +10 dB at each frequency between 1.8 and

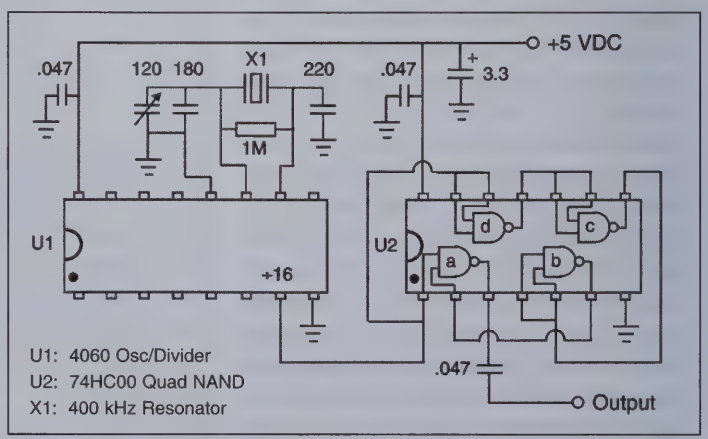



**Figure 2—Circuit diagram of the simple two-chip HF comb generator.**

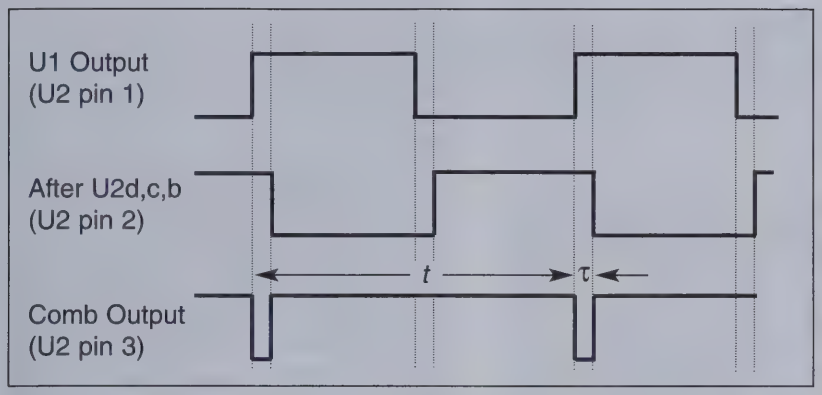



**Figure 4—Timing diagram of the digital signal through U2. The result is a series of short pulses. The repetition rate ($t$) determines the spacing of output frequencies, while the pulse width ($\tau$) determines the "first zero frequency," which also affects the amplitude flatness.**

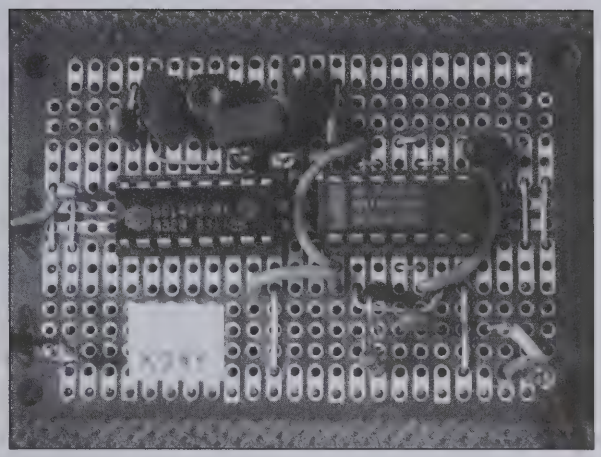


**Figure 5—The comb generator built on a Radio Shack prototyping perf board.**

30 MHz. A 0.047 µF coupling capacitor at the output provides a degree of highpass filtering to eliminate some of the low-frequency energy.

Of course, frequency spacing other than 25 kHz can be achieved by choosing a different crystal and/or divider ratio. The 4060 oscillator is only good to about 3 MHz; for higher frequency crystals, use the 74HC4060.

There are no special methods required for using the comb generator, compared to any other signal generator. Once the resonator is adjusted for an accurate frequency, your receiver will hear a strong signal every 25 kHz. With this CW tone, a deep null is easy to hear (and easy to see on your S-meter), which allows an accurate measurement. I even use this signal source with my GR-1606A high-performance R-X bridge when a project requires greater accuracy than my homebrew bridge.

### A Note About Commercial Antenna Analyzers

One-box commercial antenna analyzers combine a bridge, signal source and detector in a single unit. Since they are single-purpose instruments, they may not have a typical receiver circuit, and they don't adjust variable resistors and capacitors to get a measurement. Some don't even use the classic Wheatstone bridge, instead using some other type of sampling circuit.

These units are terrific for convenient measurements, which is why they are so popular. However, their price is in the hundreds of dollars, which makes them a significant investment for many hams. If cost is important, a homebrew bridge will make measurements that are just as accurate (maybe better) than an antenna analyzer, although you will need a little more hardware. The circuit in this article reduces the size and cost of that extra hardware. When installed inside the bridge enclosure, a receiver is the only additional item needed.




**Figure 5—Output spectrum of the comb generator over 0-100 MHz. Note the first zero at approx. 78 MHz. At lower frequencies, output level diminishes slowly with increasing frequency, and is only about 2.5 dB down at 30 MHz.**

### Additional Uses for the Comb Generator

This comb generator can perform some other signal generator tasks. For example, if you have a spectrum analyzer but no tracking generator, the comb generator's wideband output can be used as a substitute. With a signal every 25 kHz, you can see the frequency response of filters and other circuits.

The circuit is also an excellent frequency and amplitude test generator for receiver alignment and troubleshooting, much like the Elecraft SG-1. Since the output exceeds S-9 +10 dB, a simple attenuator or voltage divider can be used to get exactly S-9 output level. Each unit may need individual calibration, since the pulse width $\tau$ may not be consistent with different ICs used at U2. (I have not evaluated this beyond my own junk box ICs.) Finally, the receiver under test should have an input filter—the high peak voltage level of the pulse will overload most mixers if fed directly.

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■■

# A New TFR From China

John Graf—WA6L

It wasn't too many years ago that our choices for a "Trail Friendly Radio" were limited to simple, single-band rigs. They were fun to build and just as much fun to operate, but they were not optimized for backpacking or remote operation.

That changed in 2003 with the introduction of the Elecraft KX-1 [1]. This was a radio designed specifically for the backpacker. It was the size of a paperback book, weighed less than a pound, produced up to 4 watts of power and used internal batteries. It appealed to several segments of the QRP users, including vacationers, remote operators, and pedestrian mobiles.

Since that time, the KX-1 has gotten some healthy competition as other manufacturers have introduced similar radios. One of the most interesting is the PFR offered by Hendricks QRP Kits [2] and designed by Steve Weber, KD1JV. Although similar in many ways to the KX-1, there were a number of design choices that differentiate the two rigs. These include a higher power output and three bands instead of four.

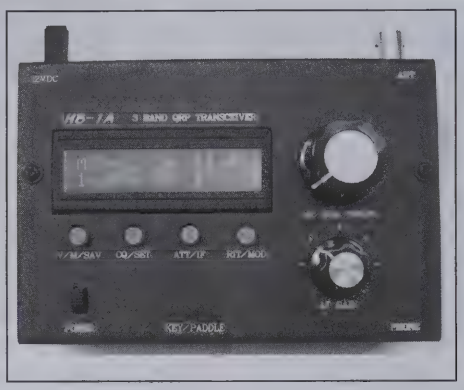



**Figure 1—The HB-1A.**



**Figure 2—The battery holders.**

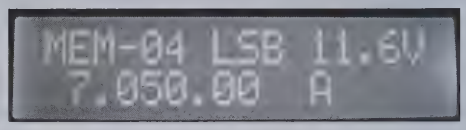



**Figure 3—LCD display.**

### From China with love

Recently, I stumbled upon a new TFR that is being manufactured and sold in China. Like the KX-1 and the PFR, it was designed from the ground up for portable operation. And like the other two rigs, its designer made some interesting engineering choices that give the QRP operator more options when choosing a rig.

The radio is the HB-1A and was designed by BD4RG (see Figure 1). As far as I have been able to tell, the only source for this rig is through an online store on eBay [3]. I took the plunge and ordered one, and it arrived direct from China, safe and well packaged, in less than two weeks.

The HB-1A is not a kit. That is the first and probably most significant design decision that differentiates this radio from the other two. There is a small amount of soldering required, as the battery holders arrive as loose parts (see Figure 2), but everything else is already mounted and functional.

Since it is not kitted, the HB-1A is able to make liberal use of surface-mount technology. A long look through a magnifying lens showed a well-manufactured circuit board with no obvious defects. More important, the rig worked fine the first time it was powered up, and I was able to start making QSOs almost immediately.

### By Design

Before discussing the operation of the HB-1A, I think it might be useful to discuss the differences between this radio and the other TFRs previously mentioned. Obviously, when designing a rig for backpacking and portable use, compromises have to be made. It is these compromises that differentiate one rig from another. Ultimately it is these differences that help you choose which rig you are going to spend your hard-earned money on.

Display: The HB-1A has a bright and easy to read LCD display. Perhaps more important, it provides a full multi-digit display of the frequency and other information (see Figure 3). This is a welcome enhancement that is lacking on other TFRs, although the trade-off may be higher power consumption.

Coverage: The HB-1A is limited to three ham bands: 20, 30, and 40 M. There is no option for 80M coverage. Additionally, it has a general-coverage receiver with a range of 5-16 MHz. The receiver has both USB and LSB modes as well as CW, so cross-mode contacts are possible.

Internals: The HB-1A designer decided not to include an internal automatic antenna tuner. This is a significant differentiator from the other two rigs, which provide an ATU, at least as an option. But what is the trade-off?

The lack of an ATU provided space for two 4-cell battery holders and a total of eight AA cells. This gives the operator a nominal 12 VDC and additional battery life. Power output with the internal batteries is a solid 4 watts. With non-rechargeable lithium cells, I have seen over 20 hours of operation, although this will vary with duty cycle.

A tuner for the HB-1A is almost certainly necessary when using compromise antennas during portable operation. There are a number of small tuners available that will fit the bill from MFJ, Emtech, and others. My choice is the T1 Automatic Tuner from Elecraft [1]. Regardless of the tuner selected, it does mean an additional component will have to be added to the backpack as well as additional cabling to go with it.

Memories: The HB-1A offers 20 memories as well as VFO operation. In memory mode, you use the main tuning dial to rotate through all programmed memories. These memories can include both ham band and shortwave frequencies.

Keyer: The HB-1A is equipped with a automatic keyer that senses both paddles and a straight key. Keyer speed is adjustable using your paddle and the buttons on the front panel.

Although there is a single keyer memory, it is not configurable. You use the front panel buttons and your paddle to enter your call sign into memory. Then, pushing the "CQ" button sends a canned CQ message with your call sign embedded. There is no way to change the message or to add an additional keyer memory.

Unlike other radios in this class, there is no option for attached paddles. An external paddle of some type is required, which plugs into the HB-1A using a standard 1/8" jack.

Filtering: The HB-1A allows you to select between four preset IF filters using the front-panel buttons. The bandwidths are 900/700/500/400 Hz. I did notice some signal attenuation when using the more narrow filters. This seems to be a common complaint with the other TFRs as well.

One nice addition to the HB-1A is a built-in attenuator that is selectable from the front panel. This is a welcome addition and is absent in other TFRs. The HB-1A also has Receiver Incremental tuning, selectable from the front panel. The RIT tuning rate is selectable between 100 Hz and 10 Hz.

Power Budget: This is an important consideration for portable operation. The specifications of the HB-1A call out 55 mA for receive, and between 350 mA and 850 mA for transmit; depending on input voltage.

**First impressions**

I like the looks of the HB-1A. I realize that this is completely subjective and that it has nothing to do with the operation of the rig. But with the bright and easy-to-read display and the well-finished metal casing, the radio is a pleasure to have in front of you. My only nit is the tuning knob, which looks like it came from a spare-parts bin. I am looking for a replacement, but in the meantime the stock knob is entirely functional.

Learning the various buttons and knobs takes a little time; all the more so due to the lack of a detailed user manual in English. Luckily, the buttons are labeled in English, and most functions are self-explanatory.

Probably the button you will spend the most time playing with is the V/M/Sav button. This is where you control the 20 available memories. One tap of the button switches you from VFO to memory mode, and rotating the tuning knob takes you through the memories. I found this feature to be amazingly useful. I have all the QRP frequencies programmed, as well as a number of SWL stations. Saving a memory is easy. After selecting your parameters in VFO mode, a two-second press of this button allows you to save them to a memory location.

The next most popular button (and next in line) is your CQ/Set button. A press of the button sends a CQ message with your call embedded. Holding the button for 2 seconds enters the CW speed control. Rather than using the display and tuning knob to set the speed, you do so with the paddle. Sending a string of "dits" incrementally increases speed, while a string of "dahs" decreases it. The next button control the attenuator and IF bandwidth, while the fourth and last button controls your RIT and mode (CW, LSB, or USB).

The fact that there are no attached paddles does affect your operating position. Other TFRs with attached paddles allow you to hold the radio in one hand while you send with your other. A table or flat surface on which to place the rig is not required.

Out of the box, you cannot do this with the HB-1A. However, there are some easy ways to get around this. My solution was the Paddlette [5] PK-1 paddle, which you can attach to the HB-1A via a magnetic strip. There are a number of other QRP paddles that will work as well, while some Hams may find the use of a separate wire-connected key to be preferable.

On the air, I found the HB-1A a pleasure to use. The display is a thing of beauty, and together with the ample memories allows for quick and accurate tuning. Although I lack the test equipment to do a laboratory comparison, I found the sensitivity and selectivity to be at least as good as my other portable rigs.

The audio is sufficient, but certainly not overwhelming. I found that when using a standard headset, the AF gain had to be near maximum for comfortable operation. Ear buds worked better, and I am sure that the selection of a high-quality set of earbuds would help even more.

I suspect that like other similar radios, the HB-1A will require a good match at the antenna to avoid spurious emissions. This is the case with many, if not most, simple QRP transmitters. During operation, I received good reports, and never a complaint of key-clicks or drift (and I asked).

Can you make contacts? You bet. I have had a ball with it so far, and am planning to take it to one of my super-secret mountain tops for this coming Field Day.

**What About Support?**

There is certainly some risk involved in purchasing a radio, sight-unseen from a foreign country. To help mitigate this risk, the seller offers a three-year limited warranty with service (if required) performed in Canada. Luckily, I have had no reason to avail myself of the warranty or the service.

I did have some initial questions for the seller prior to making payment. I received prompt replies to my email, which included a request for a copy of the HB-1A schematic.

Documentation is very limited, unless you are fluent in Chinese. The good news is that most of the operation is intuitive, and it does not take long to figure out how to use the different features of the rig. I am in the process of creating a mini-manual in English, which I will be happy to provide to interested users when it is complete [4].

**Summary**

Competition is a good thing. The HB-1A is definitely a competitor in the TFR market and offers the QRP operator a factory-built radio at a reasonable cost. While similar in many ways, there are a number of differences between the HB-1A and existing TFRs. Hams now have another choice when searching for a portable radio to fit their needs.

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# County Hunting—QRO vs. QRP vs. QRPp

Larry Cahoon—WD3P larry@wd3p.net

**The Start**

While working for the USA-Counties Award (USA-CA) from my home area in Maryland, I came to regard working stations as a mobile as something akin to running QRP. My logic was that the compromise antenna used by the mobile was much the same as reducing output power. So when I finished up USA-CA in late 1996 and began to work on the award for the second time, I considered playing around a bit with QRP. Little did I know where it would take me.

There was one major problem. I did not have a rig that would go below 10 watts. My basic rig up to that point had been an Icom 735 in the shack and a TS-50 for the mobile. Both rigs bottom out at 10 watts. So quite naturally, I started out working the counties the second time QRO at my normal 100 watts.

In the Spring of 1996, *CQ* magazine had an article with plans for a small QRP transmitter—the Micronaut. In the Spring of 1997, I built an 80 meter version of the transmitter. After many struggles, I finally set up a sked with a good friend of mine down the road a bit, Richard, WK3I, and we managed to complete a QSO over a distance of less than 20 miles. I now had my first county worked QRP and my first county worked QRPp. Of course, I had been hard at work getting the counties a second time QRO and already had 715 of the 3076 counties worked—I was almost 25% done. I don't recommend starting QRP this way as the Micronaut was only putting out about 7 mW. So this was not only the first QRP QSO it was also the first QRPp QSO. I did eventually put the 40 meter version of the Micronaut on the air in October of that year and worked four stations hitting TN, OH, NJ, and NY with a more respectable 20 mW.

Using 20 mW is also not the way to start playing with QRP. The Micronaut was really more of a toy than anything serious. About then I stumbled across the QRP-L group on the Internet and found that the Norcal group was putting out a small 30 meter rig in kit format. It was the 38 Special. Never having built much before, I figured I could risk the $25 it cost. So I purchased that kit and put together. To my

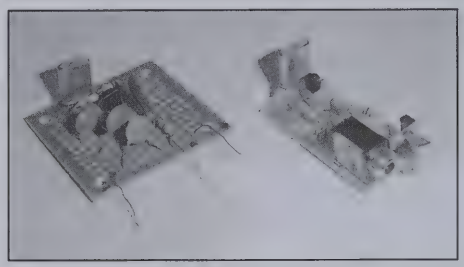


**Figure 1—The Micronauts for 40 and 80 meters.**

pleasure, it worked. So my second and third QRP/QRPp QSOs were with this little rig hitting K5ID in AR and WS4S in TN with 300 mW. I now had three counties worked QRP—all with less than a watt. 300 mW is a vast improvement over 20 mW, but it is still not the way to start serious QRP work. And on 30 meters, counties are not going to come very fast.

**First Steps**

By then, it was early April of 1997 and I had just received my plaque for Five Band DXCC. I rewarded myself with a new TS-570D. It was capable of going all the way down to 5 watts. So now, I could do real QRP work. The first test came in a small QRP contest at the end of April 1997 when I worked about 80 stations in about 25 states while running a true 5 watts.

After discovering the fun of building my own rig with the 38 Special I was ready to get a bit more serious about building a better QRP rig. My choice was the Sierra put out by Wilderness Radio. This a multiband rig that comes in kit format. I built the basic rig and put it on the air for its first real workout at the club Field Day in late June of 1997. At that time, I had only put together the one band module for 20 meters. It worked well. I don't remember how many QSOs I ran off with the rig. I really was not concerned with that as our club treats Field Day more as a social event than as a contest.

At home, I still did most of my QRP work with the TS-570D at a full five watts. By the end of August I had put together the 40 meter module for the Sierra, but I still had not gotten into chasing the counties QRP. QRO was still the name of the game. QRP was more of a side activity/interest.

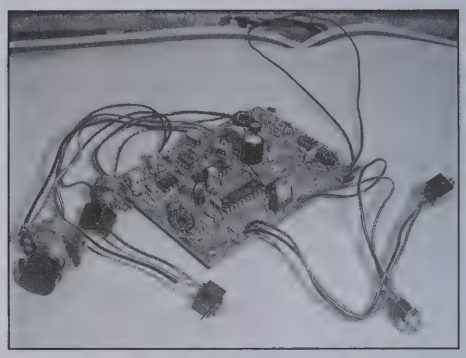


**Figure 2—The Norcal 38 Special for 30 meters.**

By August I had 1171 counties worked, about 40%, but only 100 were in the log QRP. It was not until October that I finally got serious about working the counties QRP.

**Into County Hunting QRP Style**

A real county hunter must go out mobile. I began to realize my QRP county hunting was being held up by the inability to work the counties QRP while I was out mobile. When I was out waiting for my kids at one of their baseball or soccer practices or after one of their school activities, I would bring along one of my small QRP rigs. But what really hurt was not being able to run QRP while giving out the counties. I had no intention of running the counties QRP, just working them that way. My first QRP QSOs from the mobile also came in the fall of 1997. I didn't know how to turn the TS-50 mobile rig down to 5 watts at that time, so I would take one of my small QRP rigs and would play QRP while I waited at soccer or baseball practice for one of my kids.

It was a year later in August 1998 when I modified the TS-50 to put out 5 watts. I opened up the rig and turned one of the pots down so now it run 5, 50, or 100 watts depending on the power setting. I had changed the 10 watt setting to 5 watts. It has stayed that way ever since. I did it mostly because I did not want to miss the counties QRP while I was on the road giving out counties to others.

I decided I would run the counties QRO as that is for the benefit of others. I worked them QRP when I could as that was for my benefit. I also decided that get-

ting the counties QRP would not get in the way of getting them completed for the second time. We do have to establish our priorities.

Of course, every now and then I would forget to turn the power back up after working someone QRP and end up running the county QRP. There were a few times when I did it on purpose. The most memorable was on the way to the annual county hunter convention in TN in October of 2000. I had just left home an hour earlier and was in King George County, VA. I've run that county so many times I had no intention of running it. Besides, it was still quite early in the morning; so early that most guys would not be up and listening for the mobiles. Then I heard VK4BS work a mobile. I thought, "I wonder if I could get him QRP," so I ran King George county at 5 watts and sure enough he came back to me. Now working Australia is fun anytime. It is a lot more fun doing it from the mobile while running only five watts. I have managed to work him two more times since running 5 watts from the mobile.

Running QRP from the mobile got to be so much fun I started making at least one QSO for each county I drove through when I had the chance. Now I can claim to have transmitted from 164 counties in 11 states while running QRP mobile. In addition, I have over 40 counties worked from the mobile while running 500 mW. And there is the memory of working Bob, N4CD/M with the mobile from the parking lot at work when he was on the county line of Kalawao and Maui, HI in his mobile in November of 2000. Those QSOs were at 5 watts.

**Into County Hunting QRPp Style**

The next big step was getting back into running milliwatts, or QRPp. Usually I played around with QRPp because the QRP contests had a category for it and you got extra points if you ran very low power. I didn't care so much about winning a contest. I picked 500 mW, as below that level the output of the Sierra was not as clean as it should be. My first foray into QRPp contesting was actually in the August 1997 running of the NA QSO party where I turned the power down to 0.9 watts and managed to run off about 60 QSOs.

The first mobile into the log QRPp was Jeff, W9MSE/M. I picked him up when running just under one watt while I was playing around in a small QRP contest with the rig set up in the front yard and a temporary dipole strung up in the trees. He was in Scott County, IA. The next QRPp QSO with a mobile didn't come until December 23, 1997. Bob, N4CD/M made it into the log from St Lucie county, FL. He gave my half a watt a 559. A half an hour later it was Ken, KC4UG/M, from Pike County, MS. He have me a 579 and I was hooked. It did help that over the course of the next four days Ken gave me 33 counties in MS while I was running 500 mW and only once did I get a signal report under a 559. I even got a couple of 599s. Within ten days I had 100 counties in the log QRPp. Ken has gone on to give me 77 of the 82 counties in MS when I was running half a watt or less.

So just after a year after I started working the counties for the second time I found myself committed to working them QRP and QRPp. I did set some standards for myself. First getting the counties was more important than getting the QRP. Getting the counties QRP was more important QRPp. As I never expected to get very many QRPp, I did set one additional standard. As most county hunters know, there is an acceptable relay system for getting the counties. The net control can relay the call sign, but he must verify that both stations correctly copied the signal report. So each station must repeat back what they heard before it is considered a valid QSO. It is very difficult to discourage the use of the relay system, as some mobiles rely on it just to simplify the copying of a weaker signal. In spite of that fact, I decided that I would not accept relays as long as I was running under one watt. This only made the QRPp quest more difficult. But that was fine with me.

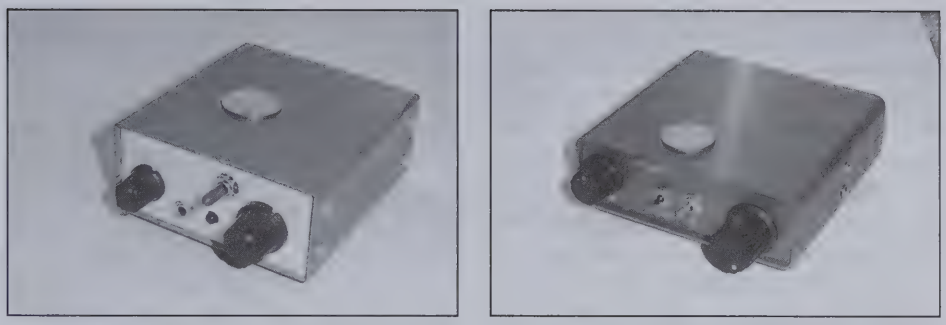


**Figure 3—My first WRP mobile rigs: (L) SST Wilderness Radio and (R) Small Wonder Labs DSW. (Note the quarter for size comparison.)**

Counties worked January 1, 1998:

QRO: 1833
QRP: 616
QRPp: 121

**THE CHASE:**
**The 2,500 Plateau QRO—March 1998**

Any seasoned county hunter knows that the first 2,500 counties come relatively easily. It is just a matter of taking the time in front of the rig. They also know that the vast majority of counties will come from the mobiles who drive around our great county with a rig in their car to give out counties to those who need them.

With that attitude I began to chase the counties QRO, QRP, and QRPp in earnest. I did have other priorities, like earning a living and getting three kids though school, so unlike some it was hopeless for me to entertain the idea of completing the counties in much less than five years. I was also curious just how much longer it would take to work the counties QRP than to work them QRO. I can't really make a fair evaluation of the QRO/QRP comparison as I decided at the beginning that getting the counties the 2nd time was more important than getting them QRP. But even with that constraint, what I found was enlightening. In the end, it was not that much harder to get them QRP than to get them QRO. Now getting them at half a watt, that is another story!

In March 1999, I reached the 2,500 county plateau QRO. That was about two and a quarter years from the start. My strategy was mostly one of working the CW county hunter's net for new counties. I learned that if the S-meter on the TS-570D said I had the mobile at about an S5 or better I could usually get him with 500 mW. If he was a bit worst than S5 on the meter

then QRP was a better shot. If he was very weak I'd go for the full 100 watts. I won't vouch for the accuracy of the S-meter on the rig, but the system worked. The S-unit comparison is not at all surprising. If one takes the traditional view that each S-unit represents about 6 dBb, then going from 100 watts to 5 watts cost about two S-units. Going to 500 mW costs another two S-units. When I do the math a 599 at 100 watts comes in at 559 at 500 mW.

PA, CA, GA, and FL QSO parties were particularly good sources for getting new counties. Usually I'd end up doing them QRP as I could get most of the counties with 5 watts. Some times I went even lower. In the spring of 1998, I built an OHR-100A for 20 meters. This rig has a pot accessible from the back of the rig that allows the power to be adjusted. I turned it down to 50 mW for the FL QSO party just to see what I could do. It was simply the case of "If it can be done, why not try it." In the end, I ran off about 30 QSOs and picked up about 25 counties.

The OHR 100A never became a mainstay of the shack. I liked the Sierra a bit too much. Besides by just switching band modules I could hit what ever band I wanted. There just was no reason to swap out a multiband rig for one that would serve only one band. However my experience with the OHR 100A in the FL QSO party got me into trying even lower power levels. 500 mW was no longer quite as acceptable. So in August of 1998, I built a little attenuator that would cut my 500 mW down to 30 mW. Then in April of 1999, just after reaching the 2,500 level QRO, I found a Ten Tec 290 step attenuator for sale on the local packet cluster and picked it up. It gave me even greater flexibility on what power I could put out.

Counties worked March 26, 1999:

QRO: 2500
QRP: 1807
QRPp: 952

**The 2,500 Plateau QRP—October 2000**

It took another year and a half to reach 2,500 counties QRP. It had taken me two and a quarter years to reach that level at 100 watt, it took three and a quarter years to do it QRP. The QRP count was gaining on the QRO count. When I started working the counties QRP, I was 1,400 counties

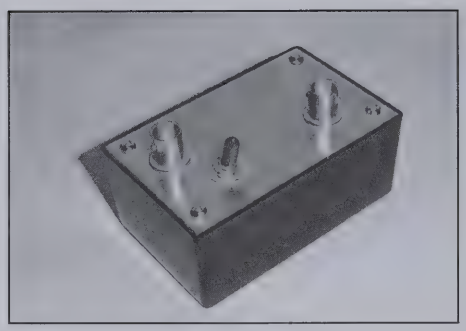


**Figure 4—My homebrew QRPp attenuator.**

behind, now I was only 300 counties behind. When I heard a county on the air that I had worked QRO, I could go after it running 5 watts. Once I had it in the log at 5 watts, I could go after it running 500 mW. After that, any power was fair game. I quickly got into the game of seeing just how low I could go.

The real test of how low I could go came in the 1999 county hunter contest. The same fellow who started me playing the counties QRPp by giving me so many counties in MS at 500 mW made it into the log at 2 mW. That was Ken, KC4UG, from his home county of Lamar, MS. Just to prove that was not a fluke, the next day I had W4VQ in FL and K4BAI in GA both in the log at 2 mW.

Counties worked October 7, 2000:

QRO: 2903
QRP: 2500
QRPp: 1615

**HI all QRP**

The mobile QRP paid off big time for HI. I picked up Honolulu and Maui counties from fixed stations. Hawaii County came from K4QFK/M in February of 2000. The last two counties had to wait until Bob's, N4CD/M Trip to HI in November of 2000. I picked him up first in Kauai County one evening from home. But getting Kalawao was a problem. The timing just did not match up. Finally I picked him up at lunch one day from the mobile setup in the parking lot at work. In the end, I worked Bob QRP in four of the five HI counties. I missed only Honolulu County. That was the first county he ran and I spent the time trying to get him with 500 mW. Had I known I was going to work him later in the other four counties, I would have turned up the power to pick him up in Honolulu as well QRP.

Counties worked January 1, 2001:

QRO: 2962
QRP: 2651
QRPp: 1813

**The Cost of QRP**

It had taken me four years to reach the final 100 counties needed with QRO and to reach the final 500 counties using QRP. It would be more than two additional years before I finished the counties for the second time QRO. By October 2001, I had spent four years chasing the counties QRP. I had 2800 counties QRP. In January 2002, I had spent 4 years chasing counties QRPp and I have over 2100 counties in the log. So four years of work had netted me all but the last 100 QRO, four years QRP had netted me all but the last 250, and four years QRPp had netted me all but 900 counties. Clearly, going QRP had not cost me too greatly. Again, going QRPp without relays was another story. This then was a time to play catch up with the QRP and especially QRPp counties while the last batch of QRO counties were coming in slowly.

The little table below shows the best comparison of QRO vs QRP vs QRPp with the bold numbers showing the count each way with approximately the same amount of time spent trying to get the counties each way. Even that is not a completely fair evaluation as getting the counties QRO always took first priority, and getting the QRP always had a higher priority than getting them QRPp. And lastly I would never use relays to get them QRPp.

| Counties worked | QRO | QRP | QRPp |
|---|---|---|---|
| January 1, 2001: | **2962** | 2651 | 1813 |
| October 1, 2001: | 3028 | **2829** | 2049 |
| January 1, 2002: | 3042 | 2877 | **2167** |

**CLOSING IN ON THE LAST ONES: AK all QRP**

Getting the first three Alaskan Judicial Districts came rather easily in the first year of working the counties QRP. I first picked up the 1st and 4th Districts from KV1M/M. Then the third district came from KL7Y in the DX contest at the end of November 1998. The 2nd District had to wait another three and a half years. In June

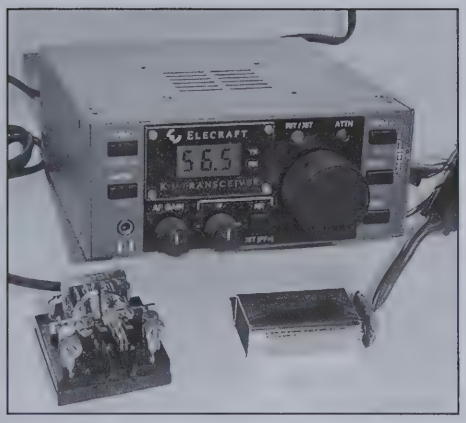



**Figure 5—The K1 with G4ZPY paddles and a single 9V NiMH battery used to work 47 states so far!**

of 2002 Bob, N4CD/M, headed to AK. I had very little success getting him in the other three districts. But the propagation was just right when he got to Nome and he made it into the log. The same fellow had given me the last county in both AK and HI. With those two states under my belt it was clear that getting the rest of the counties QRP was just a matter of time.

**Slow but Steady Progress**

From then on till late 2002, it was a matter of slow steady progress. I built an Elecraft K2 in the spring of 2000 and followed that up with an Elecraft K1 later that year. Once those rigs were completed, they replaced the Sierra as the rig of choice for QRPp operations. I kept the Ten Tec attenuator on the K1 so it was used for QRPp most of the time. The K2 would come into play if someone moved to 15 or 10 meters and I had to follow them. The TS 570S was used for QRO operations. It was also used when I ran QRP at five watts.

At the end of 2002 I needed only two counties QRO. I still needed 43 counties QRP. And QRPp? Well, that was far behind with 591 counties to go.

Counties worked January 1, 2003:

QRO: 3075
QRP: 3034
QRPp: 2486

**The Last Six for 2nd Time Around QRO**

The first of December 2002 found me with six to go to finish up the counties QRO for the second time. The first five came in quick succession during December and early January. The last one was Blaine, MT and took quite a bit longer.

| County | Date (m/d/y) | QSO Partner | Notes |
|---|---|---|---|
| Jewell, KS | 12/1/02 | Jim, WA7SLD/M | Made a major detour to help |
| Echols, GA | 12/7/02 | Ray, WG6X/M | Made a special trip to help |
| Evans, GA | 12/8/02 | Ray, WG6X/M | Part of Ray's special trip |
| Jefferson, IN | 12/14/02 | Jeff, W9MSE/M | Drove out of his way to help |
| Reynolds, MO | 1/2/03 | Paul, WAØISE | A resident ham for once! |
| Blaine, MT | 9/6/03 | Jim, KØEVE/M | Drove out of his way to help |

The guys who helped me are shown in the table at the top of the page. Notice that in five of the last six QSOs, these good hams spent their time and resources to help another ham without recompense of any sort, other than a sincere "Thank You." Aren't hams a great bunch of people?

I should also mention that, even though these QSOs were intended to aid in my QRO attempt to get my second USA-CA award, five of these QSOs were done using QRP power on my end. In fact, two of the county QSOs, Evans and Jefferson, were done with QRPp power.

**The Cost of QRP—Revisited**

Well, what about the QRP vs QRO comparison? Remember when I finished up QRO, I had spent about nine months less working the counties QRP. So the best comparison should be made nine months later when the same amount of time had been spent for both QRO and QRP. When I finished up, I only needed four counties in two states to finish up QRP. The QRPp count stood at 2,585 with 492 to go. The average power required to work a county for the 2nd time around was 1.16 watts. By state the average varies from a high of 12.4 watts for NV to a low of 7 mW for NH. Of the 50 States, 26 came in with an average power of under one watt. Two states came in with an average of over five watts to work a county—ID and NV.

Counties worked September 6, 2003:

QRO: 3077
QRP: 3073
QRPp: 2585

| Nr. | County | Date | QSO Partner | Notes |
|---|---|---|---|---|
| 25 | Wayne, MO | 4/20/03 | Dave, WØCH/M | |
| 24 | Golden Valley, ND | 5/18/03 | Ed, N3HOO/M | |
| 23 | Judith Basin, MT | 5/18/03 | Ed, N3HOO/M | |
| 22 | Howard, MO | 5/22/03 | Dave, WØCH/M | Drove out of his way to help |
| 21 | Wirt, WV | 5/25/03 | Diz, W8DIZ/M | Made a special trip for me |
| 20 | Carter, MT | 6/8/03 | Joyce, KD8HB/M | |
| 19 | Sioux, ND | 6/13/03 | Joyce, KD8HB/M | |
| 18 | Bear Lake, ID | 6/27/03 | Ken, WØETT/M | |
| 17 | Frontier, NE | 7/13/03 | Mike, WU3H/M | Drove out of his way to help |
| 16 | Washington, ID | 7/13/03 | Darrell, W6TMD/M | Father/son trip; son is N6MJ/M |
| 15 | Teton, MT | 7/14/03 | W8LVN/M | Chance QSO; not prearranged |
| 14 | Pendleton, KY | 7/14/03 | Dave, WØCH/M | |
| 13 | Dunn, ND | 7/17/03 | W8LVN/M | Chance QSO; not prearranged |
| 12 | Daggett, UT | 7/25/03 | N6MJ/M | |
| 11 | San Juan, CO | 7/25/03 | WA7JHQ/M | |
| 10 | Piute, UT | 7/25/03 | N6MJ/M | Three rare counties today! |
| 9 | Grant, ND | 8/10/03 | Jerry, WØGXQ/M | |
| 8 | Nicholas, KY | 8/10/03 | Dwight, KM4FO/M | Chance QSO; not prearranged |
| 7 | Mercer, ND | 8/10/03 | Jerry, WØGXQ/M | |
| 6 | Morgan, KY | 9/6/03 | Diz, W8DIZ | |
| 5 | Blaine, MT | 9/6/03 | Jim, KØEVE/M | |
| 4 | Boundary, ID | 10/1/03 | Bob, N4BP/M | |
| 3 | Fremont, ID | 10/2/03 | Bob, N4BP/M | |
| 2 | Lander, ID | 10/2/03 | Bob, N4BP/M | Drove several hundred miles out of his way |
| 1 | Eureka, NV | 10/2/03 | Bob, N4BP/M | First all QRP-CW award! |






**Figure 6—Entering some of the very last QRP counties! (Photos courtesy Bob Patten, N4BP).**

**FINISHING UP QRP:**

This section is designed to give credit to those who gave me the last 25 counties QRP. These were the last of the 3,077 QSOs needed to complete USA-CA all QRP-CW. When it happened, it was the first time an all QRP-CW award had been accomplished!

The last 25 counties and the hams who generously helped me are listed in the table at the bottom of the previous page. Several things are interesting about the list.

First, all of the stations were mobile. This is a common occurrence when chasing the USA-CA award. Many of the rarer counties have very few, if any, active hams in them, which is what makes them rare in the first place.

Second, many of the QSOs happened on a county hunters net. This too is typical. In addition, the mobile hams often are kind enough to list their trips ahead of time on Internet reflectors devoted to county hunting. This is very helpful to hams chasing the last few counties needed for the award.

Third, and most important, several hams drove a significant number of miles out of their way just to help a fellow ham. I have noted their contributions in the table. Perhaps the most generous ham in this respect was Bob, N4BP, who drove several hundred miles extra to get me the last four counties I needed. I can only say "Thank you!" to all of the hams who put forth this extra effort.

**The Cost of QRP—The Final Word**

Well, what about the QRP vs QRO comparison? Remember when I finished up QRO, I had spent about nine months less time working the counties QRP. In the end, it took me eight months less effort to get the counties QRP than it had to get them QRO. Even if I count from my very first QRP QSO, it still took four months less time to work them QRP. The average power required to work a county QRP came in at 1.08 watts. Of the 3077 counties, 2585 of them were worked QRPp; with under one watt. By state, the average varies from a high of 3.2 watts for MT to a low of 7 mW for NH. Of the 50 States, 26 came in with an average power of under one watt. ●●

**Do you have a QRP "adventure story" to share with *QRP Quarterly* readers?**

**If so, just contact one of the Associate Editors listed on page 3 (or any of the club's officers if you know them). Tell them what you have in mind and they will help get the story into print!**

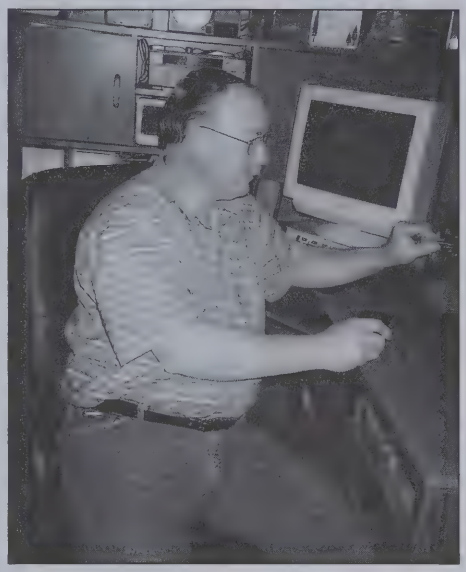
# 45 Years in Ham Radio

Jim Crawford—K5YC ihz2@valornet.com

Many years ago when I was just a youngster, a new thing called CB came along. I finally persuaded Dad, who owned the local radio and TV store, to help me get one of those new mystery things. He didn't think a young lad needed one. I sure was in heaven if I even heard someone on those old receivers—broad as a barn, as the saying goes. They received AM only. CB was in the 27 MHz band, knocking out one of the old ham bands. The government did a study and said this band was of little use and would not reach very far. How wrong they were! CB boomed and in the 70s broke loose with mass confusion on any channel. I wanted something better.

When I was about 12 years old, several of the old-ime hams and good friends introduced me to ham radio. You can imagine how my eyes sparkled as a youngster. Back then, to hear someone on the other side of the world using a room full of homebrew equipment reaching nearly to the ceiling was the "cat's meow" as they say. I just had to find out more and get involved in this newfound hobby. Sam, N5AF; Jay, W5DN; Walter, K5ZOB; and others prepared me with study material for the Novice license. Morse code was a challenge at first, but I made up my mind to learn it. At this time I was still in grade school, so I had to do studying at night after homework when Mom and Dad had gone to bed.

Allied Radio in Chicago, Ill., was big on kits and ham gear back then. I sold the old CB and with the money ordered me a "Space-Spanner" 3 tube receiver kit. Now I was on my way! I would spend 30 minutes several nights a week listening to what code I could pick out on the radio. Sam, N5AF, drilled me on the technical side of ham radio. Jan, W5DN, helped with code. Before long I could copy code pretty well



I thought.

Might as well try the test. I got two of the old Generals to give me the test. Back then, they had to order test material from the FCC. Seemed like it took forever, but the material finally came in the mail. I took the test and passed the written part. Now for the code test. Boy, was I nervous! But I was able to copy at 8 wpm, more than the 5 wpm I needed. Waiting on my new license to come in, I now built my first CW transmitter with the help of Jay and others. I think I had more solder on me than the project. It was a small tube rig. Jay came to my rescue and helped fix all my mistakes. Next, I put up a long wire antenna. I really don't know what the SWR was, but it worked when Jay fired up my little CW rig and made a contact. I don't know who was more excited, Jay or me.

Finally one day, Mom came in my room all excited. She had an official letter marked "FCC—very important"! What is this and what is going on was on her mind. Was I in trouble? I slowly opened the letter and low and behold I saw my new ham call, WN5EMN. I quickly explained the situation to her. Since that time I have really enjoyed ham radio and made many memorable QSOs.

I am now an Extra Class ham with the 20 wpm certificate. My wife, after hearing me on that noisy thing, with the kids all grown up and much persuasion on my part, decided to join me in this wonderful hobby. Her call is KD5IHZ. She and I both enjoy weak signal work on the 6, 2, and 432 bands. Thru the years I have had many different sets—some homebrew, others bought. I still enjoy building different types of antennas and experimenting on some project.

Nearly all my ham years, I have used low power and enjoyed it. Never running more than 150 watts; most of the time I run QRP. People ask me, "Why QRP? Why not have an amp?" Well, I for one find QRP very exciting. It brings back some of the excitement I had as a young lad making contacts around the world with my small CW rig. QRP grows on you. Being able to bust a big pile-up on a DX station with all the high power stations calling gives you a wonderful sense of accomplishment. QRP is a challenge for sure, but one that is well worth it. With patience and a good antenna you too can be making contacts with QRP power. I have many awards that I have earned using low power—WAS, DXCC, contests, and many more. QRP is one area of ham radio where kits are still available. You can even build a transmitter or receiver yourself out of a handfull of parts. Or you can modify something, like the old SSB Citizens Band rig shown in the photo. I made both WAS and DXCC with that old rig. It's exciting to get something to work that you built. To me, ham radio is still an exciting hobby after all the 45 years I have been licensed.

*Jim Crawford, K5YC, #4697*

# FDIM 2009 in Photographs

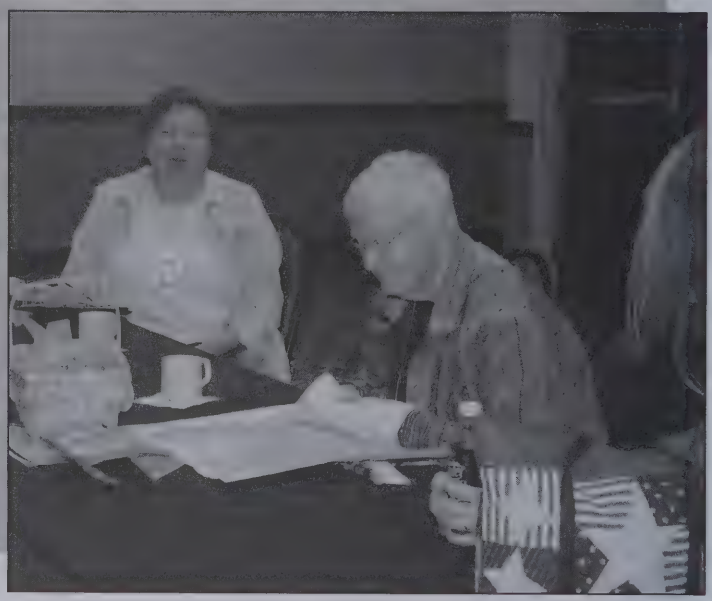


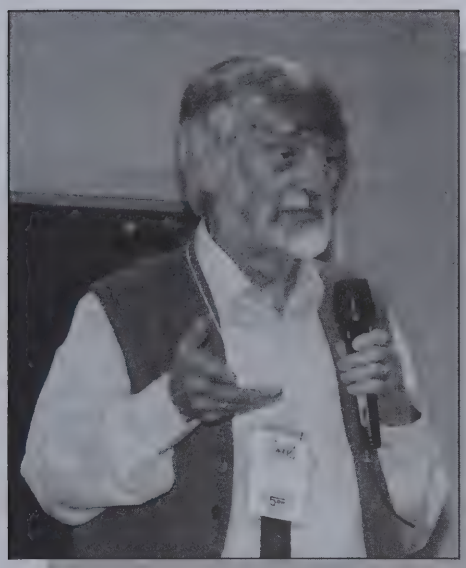




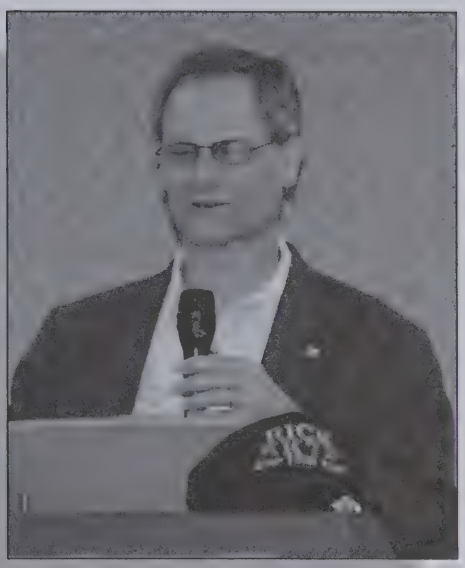


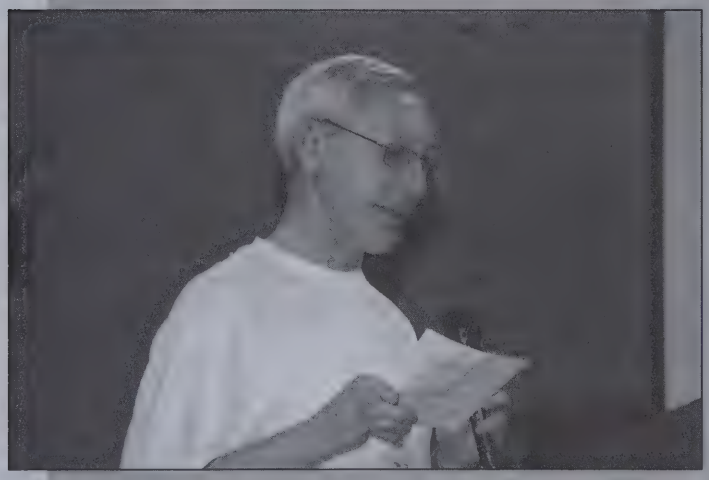


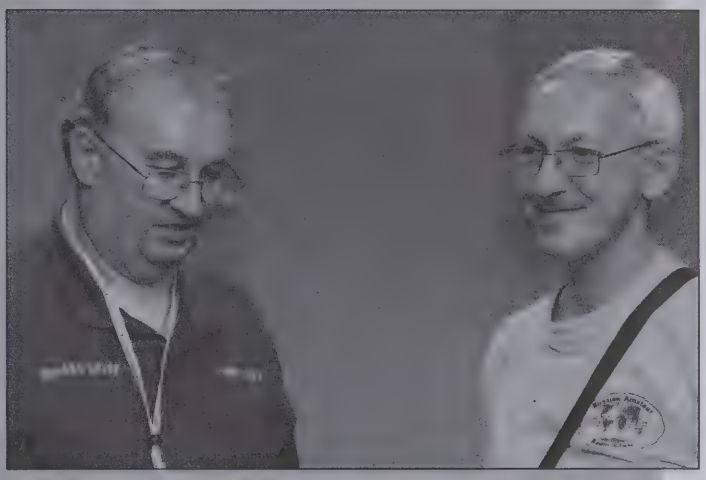



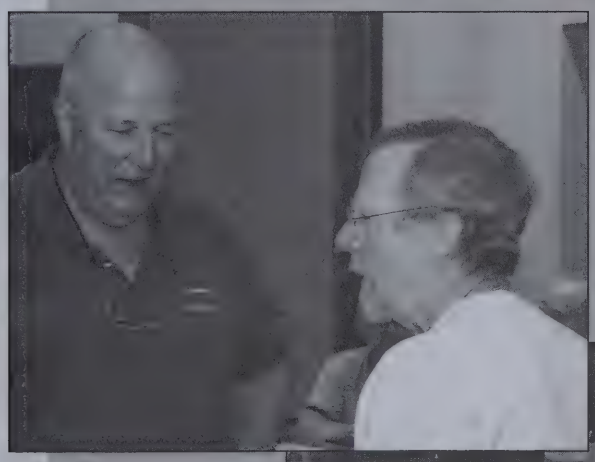








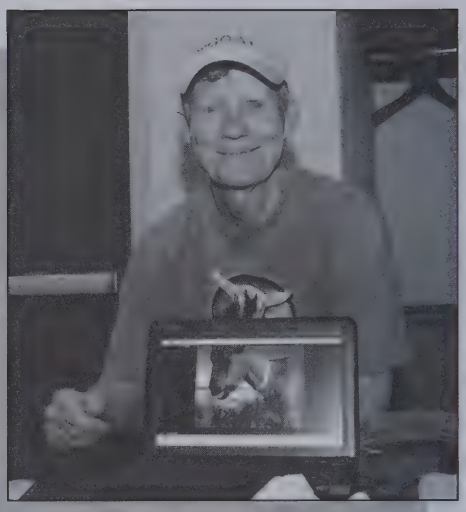




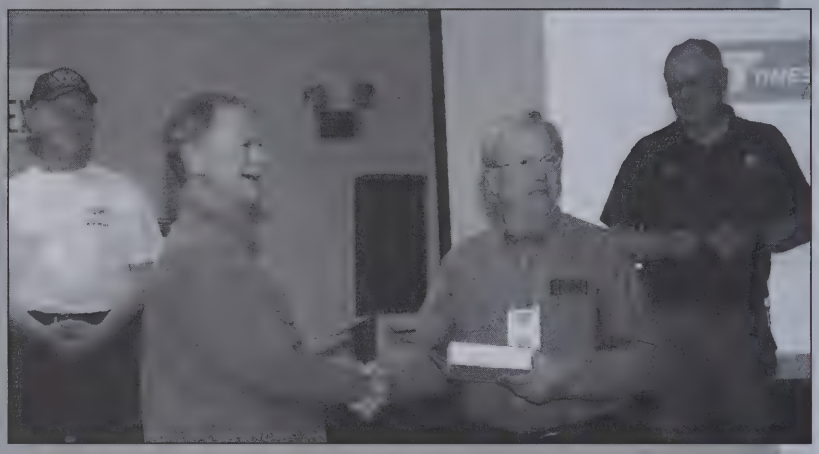

Indiana
Kits





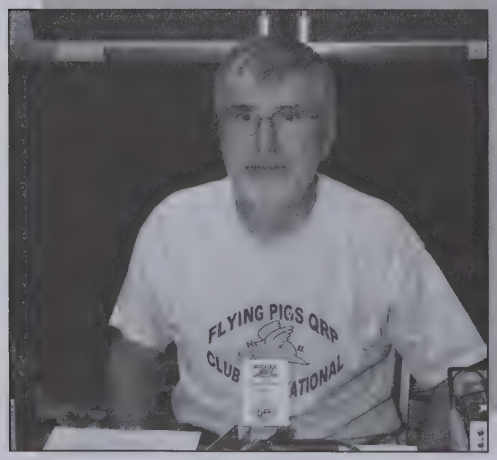


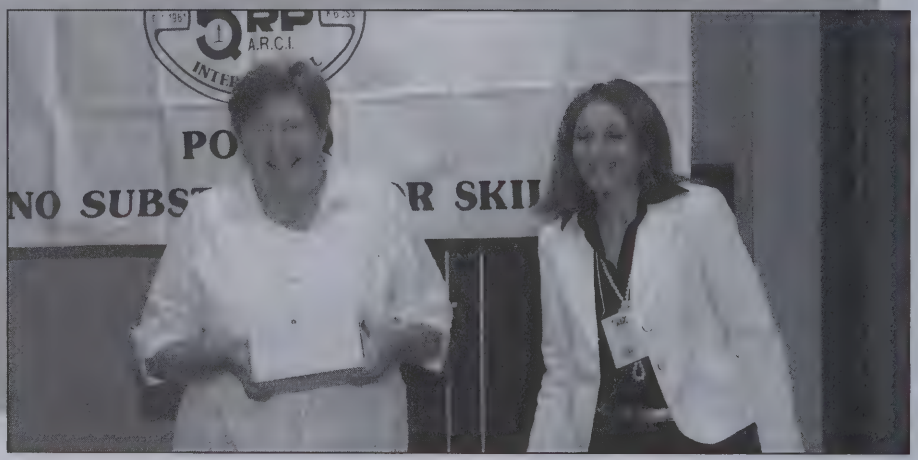





SDR-Kits
SDR-Kits




FLYING PIGS QRP


QRP
A.R.C.I.

# Step Attenuator (1-1000 MHz Homebrew)

Paul Harden—NA5N

na5n@zianet.com

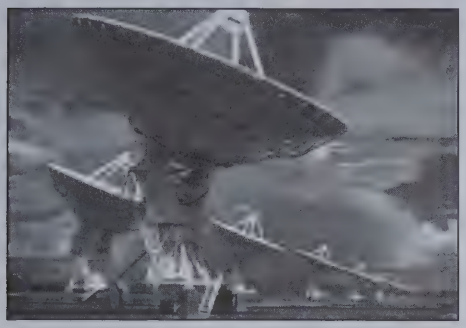


**Figure 1—The Very Large Array (VLA).**

This was actually a crash project at work. I was asked to design/build a noise source test set with some total power detectors (TPD)—requiring a step attenuator for calibration. The frequency range of interest is about 50-500 MHz and preferrably to 1200 MHz to cover the lower end of L-band.

The overall project was interesting: to measure the total wideband power in the VHF/UHF TV range before—and after—the conversion from analog to digital TV.

The VLA uses receivers at 74 MHz and 308-408 MHz for science, but due to the analog VHF stations, with great difficulty. Though we're 100+ miles from Albuquerque, TV interference is considerable. It is hoped that once the analog VHF TV signals cease, the total power in this frequency range will drop to be closer to the "sky noise" (terrestrial and ionospheric noise as if no manmade signals were present, i.e., radio astronomy). This noise test set will also be used for the 74/327 MHz system.

We have numerous commercial step attenuators in the lab. However, you don't want to put an $800 attenuator in a piece of test equipment that will see infrequent use. Commercial step attenuators good to at least 1 GHz cost several hundred dollars; those for the microwave frequencies push $1,000. See Figure 2. Worse, for this project, it would take a couple of weeks to receive a commercial attenuator after ordering it.

I needed to make a step attenuator NOW. I saw this as a nice QRP project to see if I could make a step attenuator with some toggle switches, even though most information on the subject yells at you




**Figure 2—Commercial attenuators.**

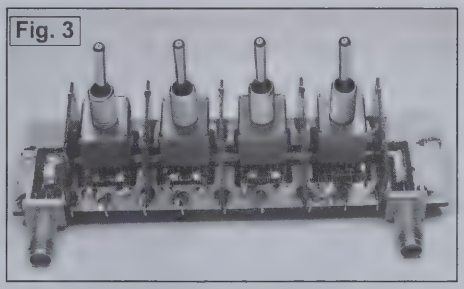
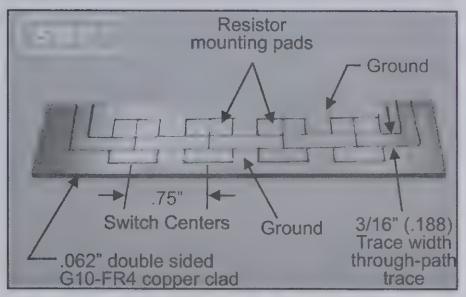



**Figure 3—Homebrew step attenuator, DC-1 GHz.**

about not using toggle or slide switches above 30 MHz, etc. Indeed, connecting the switches together with leaded resistors and buss wire does add inductance—causing resonances and notch effects combined with the stray capacitances. There's a couple of good construction articles to be found on the internet on step attenuators, but seriously lacking any real performance data. The exception is Jason Milldrum's site, http://www.nt7s.com. A nice step attenuator project with some good measurements.

In an attempt to reduce stray inductance and capacitance, I thought I would try







**Placing the copper clad board, marked with the cutouts, into the milling machine vice. I used a 1/16" (.0625") bit.**

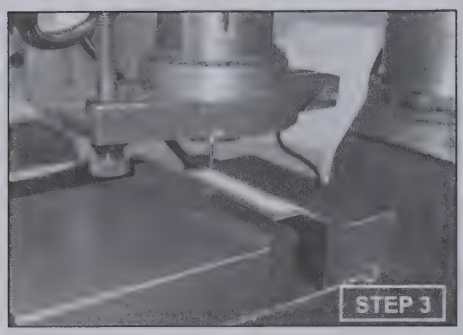
mounting the switches on a piece of copper clad by soldering the switches to traces surface-mount/Manhattan style. See Figure 3. Using mini toggle switches, the spacing between the switch solder tabs was 3/16" (.188"). I decided to use this spacing dimension as the trace width rather than the standard 100 mils for 50 ohms. Whether lucky or by skill, the end product came very close.

I decided to photograph the project as I built it to document the success or failure to share with QRPers attempting to build a step attenuator.

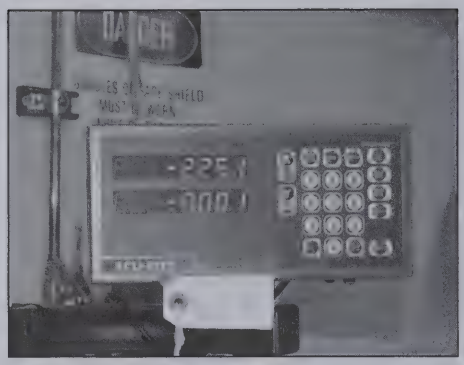
**Contruction Steps**

**Step 1:** I laid out the switches on .75" centers with the 3/16" (.188") switch terminal spacing as the width for the traces connecting the "common" poles of the switches (the "through path" trace) and to the input/output SMA connectors. BNCs could be used just as well. A marker was used to highlight the lines to be cut.

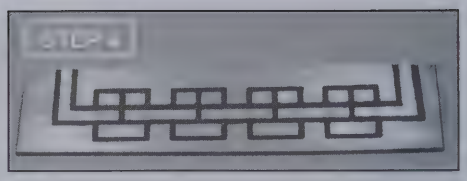
**Step 2:** Cut out the traces and pads. I decided to use our milling machine. (I mean, come on! If you had a choice between a Dremel tool and a milling machine, which one would you decide to

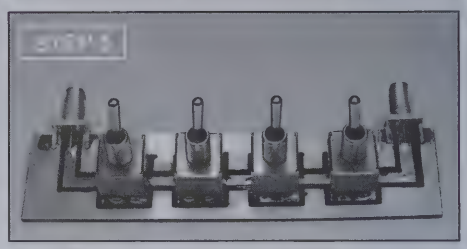


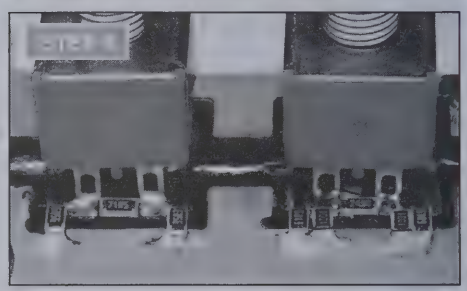

**Milling the traces. On a milling machine, the vise moves to make the cuts. Depth of bit was just enough to cut the copper into the G10-FR4 material.**



**Of course, a DRO (digital readout unit) helps get the cuts evenly spaced and in the right place.**







play with ... err, I mean use?). A Dremel tool would have worked just fine for making the cuts and with the same results except for the unavoidable overcuts to adjacent traces (and depending on how steady your hand is). The .188" traces .065" for the milling bit yielded an actual trace width of about .130" a bit wider than the recommended 0.1" for a 50-ohm trace.

**Step 3:** After milling (or cutting with a Dremel tool), just basic cleanup, removing burrs—and shine it up a bit if you're going to take photographs to share with fellow homebrewers!

**Step 4:** I solder tinned all the traces to make soldering easier and to avoid using excessive heat in soldering on the toggle switches and SMA connectors. The tinned areas are the signal areas; the remaining copper areas are the ground plane. The grounds will be tied together when mounting the SMA connectors.

**Step 5:** Mounted and soldered the toggle switches and SMA connectors. There are no mounting holes going through the board. The toggle switch solder tabs were soldered directly onto the pads "surface mount" or Manhattan style. SMA connectors are edge-mount PCB types with solderable ground tabs on both top and bottom sides of the copper clad. This is an important distinction at this point as the bottom copper layer is grounded to the top ground areas only at these two points (to be discussed in Step 8).

**Step 6:** Mounted and soldered the attenuator resistors. I used 1206 SMC resistors to reduce inductance from leaded resistors to strive for a flat response. If leaded resistors are to be used, I would recommend 1/8 W resistors for their smaller size over 1/4 W and mounting identical to the surface mount version shown here. *Keep leads at a minimum.*

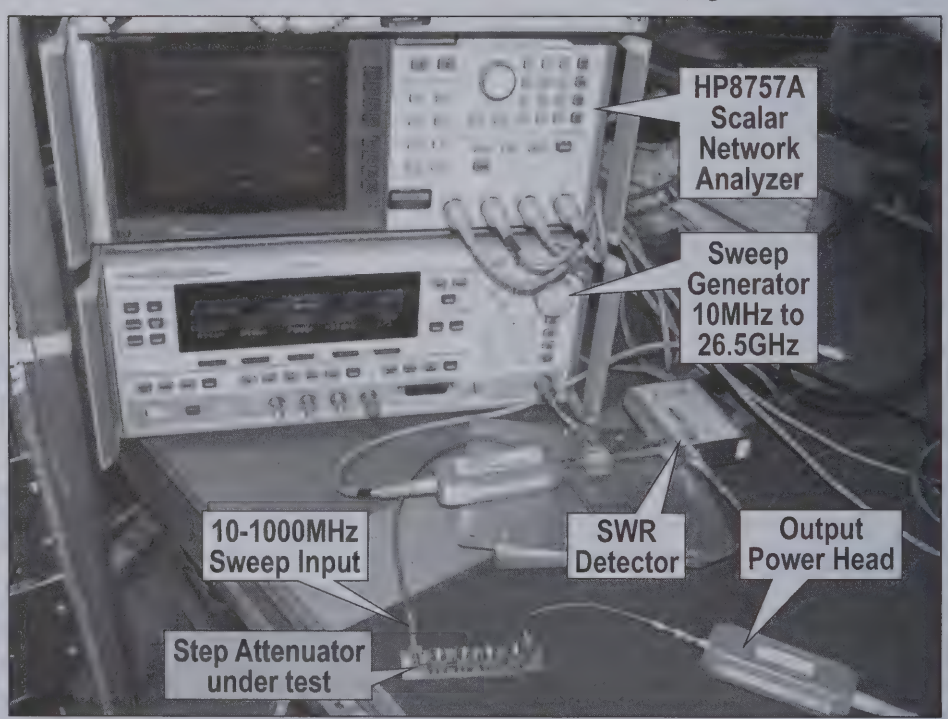
The switch on the right is the 20 dB switch. Initial testing yielded about 18 dB. I paralleled the resistors to drop the attenuation to 20 dB. In later testing, this proved unnecessary.

See schematic at end of article for values. The attenuators I needed were 3 dB, 10 dB, 10 dB and 20 dB for a 43 dB dynamic range. The total power detector (feeding an analog-digital converter) is calibrated in 10 dB steps, and 3 dB for half-power points. This is preferred by the astronomers in converting noise power in dB into noise temperature in degrees Kelvin. For a larger dynamic range, you can add additional switch sections. 40 dB is all I needed for this particular project.

I wanted to see how the attenuator performed "as is" up to this point before adding barrier shields between the switches, improving grounding, and how close I was to maintaining 50 ohms over the frequency range.

**Initial Testing**

For testing the step attenuator, I used a Hewlett-Packard (Agilent) 8757A Scalar




**The test setup.**




**Figure 4—Response at 0 dB—with all switches OFF. This shows the "through path" loss, which is 1 dB at 500 MHz and 1.8 dB at 1 GHz. The SWR is generally <1.2:1 showing the 50 Ω impedance is fairly wellbeing achieved. The SWR ripple shows theimpedance is changing vs. frequency.**




**Figure 5—Response at 10 dB (1st 10 dB switch ON)—maintaining 10 dB attenuation quite well to 500 MHz. The slight downward slope is due to the "through-path" loss. The 3 dB drop in loss around 700 MHz is likely due to a resonance condition. Note how the impedance (SWR) also changes at this point.**




**Figure 6—Response at 10 dB (2nd 10 dB switch ON)—also maintaining 10 dB attenuation very well to 500 MHz and an identical impedance problem around 700-900 MHz.**

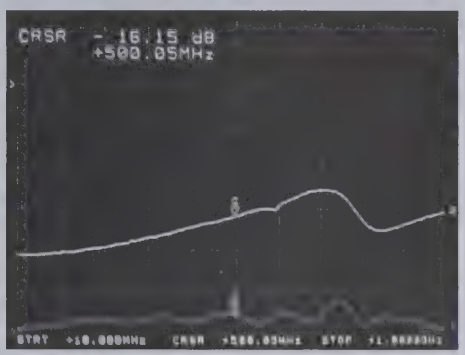
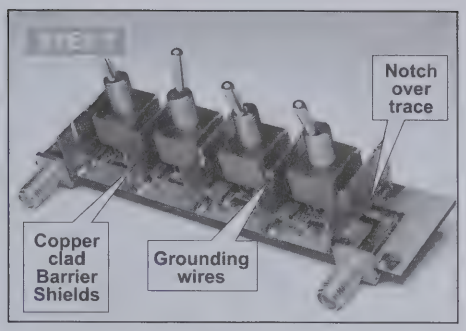
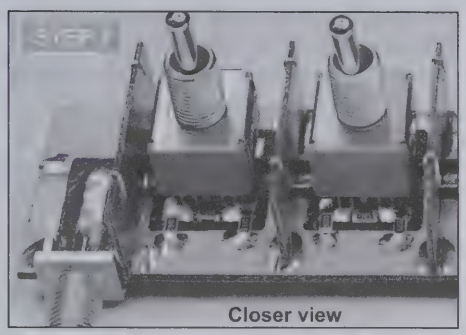
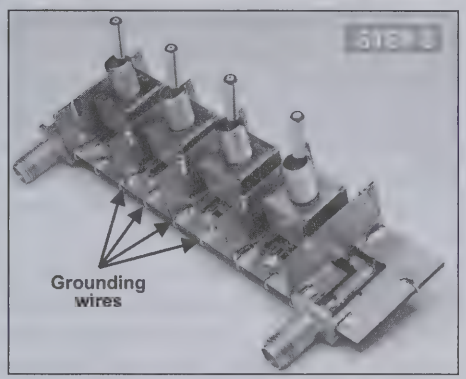
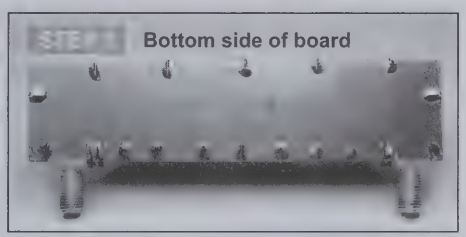



**Figure 7—Response at 20 dB (20 dB switch ON)—with a fairly poor response above about 200 MHz. Since the SWR does not track this, this is likely caused by poor isolation (leakage coupling, grounding or other problem). Power leakage is to be expected in the 20 dB stage.**




Network Analyzer (SNA). This piece of test equipment is similar to a spectrum analyzer with a tracking generator. It tests a two-port circuit by sweeping the circuit over a specified frequency range and plotting the response. Additionally, it measures the reflected power, or SWR, to indicate the deviation from 50 ohms over the frequency range.

**Test Waveforms.** For the following test waveforms, the step attenuator was swept from 10M Hz (min. frequency of the HP8757) to 1000 MHz (1 GHz). Thus, the horizontal display is 100 MHz per division. The scalar, or magnitude, display is 5 dB per division. I calibrated the display to show gain/loss of the circuit in dB, rather than absolute power (dBm). This is the WHITE [top] trace. Injection power was –10 dBm.

The RED [bottom] trace is the SWR, set for 1.4:1 per division. That is, the very bottom division is 1:1 SWR; the next division upward is 1.4:1.

The initial tests shows the step attenuator, "as is," would be suitable for all HF work. The goal is to improve the performance to at least 500 MHz and improve the impedance (SWR).

**Contruction Steps (cont'd)**

**Step 7:** Barrier shields were placed between each switch and the ends. The shields were made from double sided .032" copper clad soldered to the top ground copper. A nibbling tool cut a notch where the shield passes over the traces between the switch "common" terminals. Small loops of wire were placed on the tops and soldered to ensure good grounding between both sides of the copper shield.

**Testing.** A sweep on the HP8757A SNA showed virtually no change in SWR except a slight improvement to the 700 MHz "hump" at 10 and 20 dB. In short, shielding offers little for impedance control, but does improve isolation through the 10-20 dB switches. (If connections between switches used buss wire and leaded resistors suspended in mid-air, shielding would be more important).

The next step was to improve the RF grounding between top and bottom ground copper regions. As stated previously, the

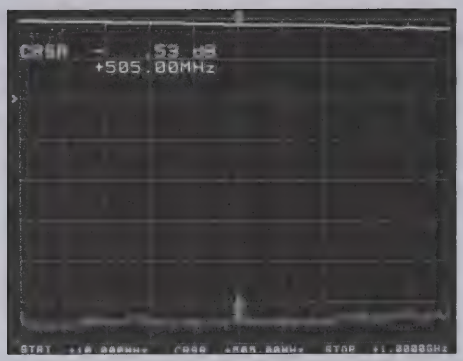



**Figure 8—The 0 dB "through path" shows a 2x improvement, from 1 dB to 0.5 dB loss at 500 MHz.**

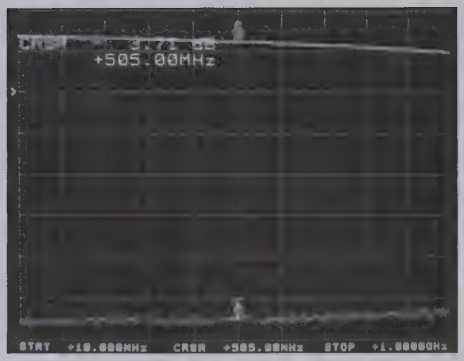



**Figure 9—Response at 3 dB (3 dB switch ON).**

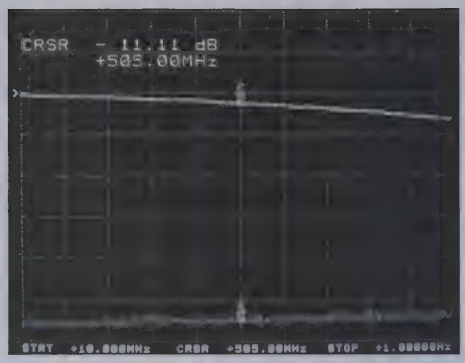



**Figure 10—Response at 10 dB (1st 10 dB switch ON)—the response is identical for both 10 dB attenuators. Loss at 500 MHz about 0.7 dB.**

bottom copper ground plane, which helps establish the impedance of the top side traces, is only grounded together at two points—at the SMA connectors on opposite ends of the board.

**Step 8.** To improve the RF grounding, I soldered more small pieces of wire (I used #26 solid wire wrap wire) along the edges of the board and at the barrier shields. Soldering the wires to the top and bottom copper makes numerous connections between the top and bottom ground planes.

An alternative to this approach would be to make numerous small holes through the board; insert a wire or resistor lead through the holes and solder on both top and bottom. This later approach emulates good RF PCB layout practices of applying numerous plated feed through holes to connect the ground layers. (The reason I didn't do it is because I should have drilled the holes before soldering on the switches and barriers!) The bottom view of the board is also shown.

**Testing.** The enhanced grounding is clearly evident in Figures 8-12.

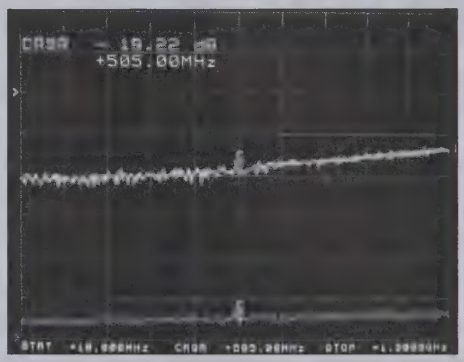



**Figure 11—Response at 20 dB (20 dB switch ON)—upward slope >500 MHz suggests leakage.**

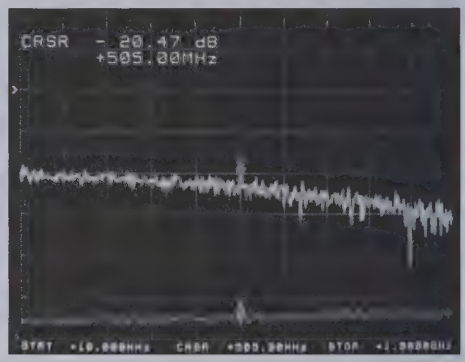



**Figure 12—20 dB response with both 10 dB switches ON. Downward slope follows through-path slope.**

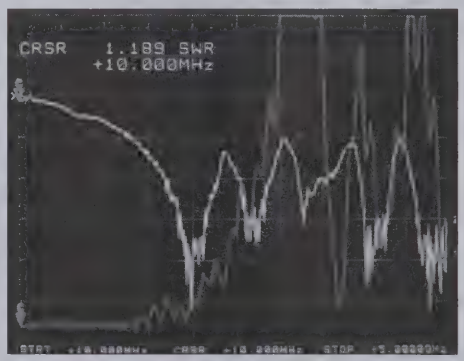



**Figure 13—Sweep 10 MHz to 5 GHz (500 MHz/div.).**

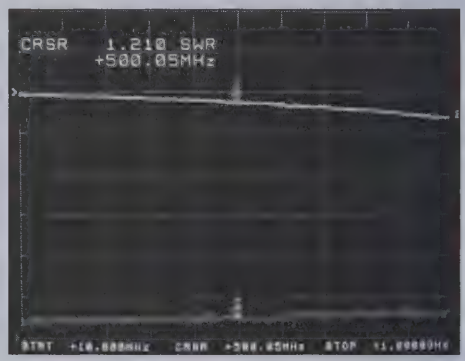



**Figure 14—Step Attenuator sweep to 1 GHz, with the cursor showing a very respectable 1.2:1 SWR at 500 MHz—comparable to commercial attenuators.**

### Final Testing

As suspected, ensuring a stiff RF ground made a profound difference.

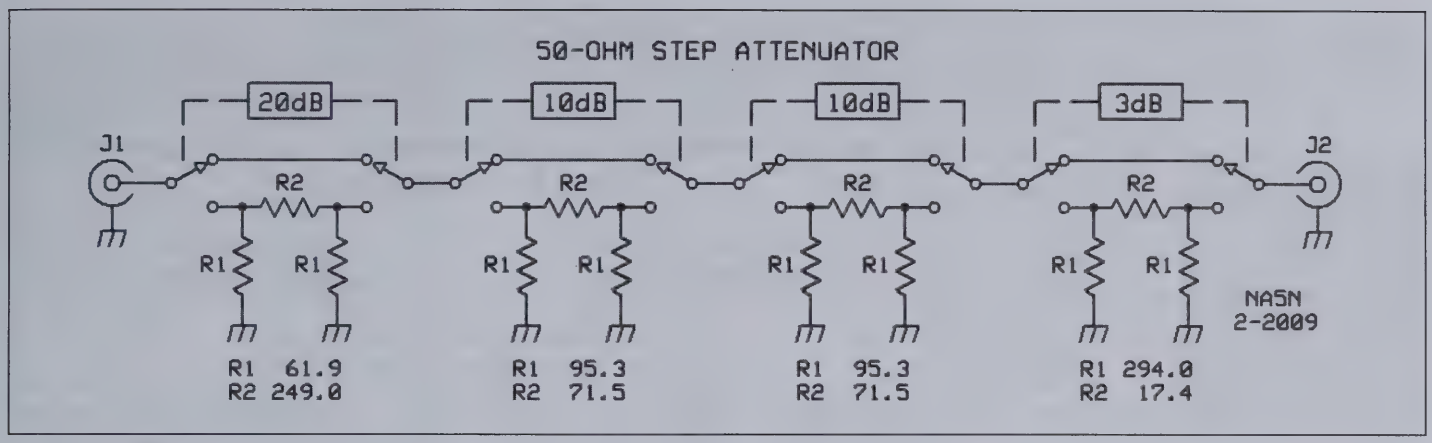
Waveforms identical to previous tests: Horizontal 100 MHz/division; Vertical 5 dB/division; magnitude is the TOP trace; BOTTOM trace is the SWR.

The nearly flat SWR indicates a consistent impedance over the frequency range and at the different attenuator settings. This means the step attenuator provides a very consistent load and 1.2:1 SWR to the driving source and the load regardless of which attenuators are on or off.

Sweep power was set at –20 dBm (vs. –10 in first tests). Figures 11-12 are a bit noisy due to the resultant –40 dBm approaching sensitivity of the power head. (Too lazy to reshoot the pictures at –10 dBm!)

### Just For Fun... (A little lesson on FR4 PCB material)

Figure 13 is a sweep of the step attenuator in the 0 dB (through path) setting, *sweeping to 5 GHz.* This shows the classic high frequency response of G10/FR4 PCB board material. This demonstrates why FR4 copper clad is seldom used at frequencies much above 1 GHz. The notches and peaks, about every 600 MHz at 2 GHz and above, are caused by resonances set up by the .062" spacing between the double sided copper clad. The two copper plates




become a waveguide of sorts.

On a PCB, maintaining 50-ohm traces (for low SWR) is a function of the trace width calculated from the dielectric constant, about 4.3-4.7 for .062" copper clad. However, the dielectric of FR4 decreases above about 1.5 GHz, requiring wider and wider traces to maintain 50 ohms. The SWR goes to >5:1 around 3 GHz, and that's using a 3/16" wide trace across the board!

An FR4 circuit board is improved somewhat by using a 4-layer board with an internal power and ground plane. Losses and resonances are reasonable to about 2-3 GHz. However, in some regards, above that it gets worse. You get huge notches around 3-4 GHz and again at 6 GHz with depths of 12-20 dB. This is caused by the plated feed thru holes from the top to bottom layers acting as tuned stubs around 3 GHz. Ground feed thrus from the top layer are terminated to the internal ground plane. This leaves an unterminated feed thru to the bottom layer, becoming a tuned stub around 6 GHz.

At microwave frequencies, PCBs are made using Rogers, Duroid, or ceramic based materials. These PCBs have consistent dielectrics and lower losses in the microwave frequency range. They're also significantly more expensive than FR4, and specialty board houses are needed for fabrication.

Figure 14 is another 10 MHz - 1 GHz sweep of the step attenuator, except the cursor is set to display the SWR—a respectable 1.2:1 at 500 MHz. If you build a step attenuator similar to the approach presented here, you should have no problems using it to 500 MHz. The one I built is already mounted in the test set. I will be curious to see if there are any differences now that it is fully shielded and mounted in a metal chassis.

| 50Ω ATTEN | CALCULATED VALUES R1 | R2 | 1% RESISTORS (E48) R1 | R2 | 5% RESISTORS (E24) R1 | R2 |
|---|---|---|---|---|---|---|
| 1dB | 869Ω | 5.8Ω | 887Ω | 5.6Ω | 910Ω | 5.6Ω |
| 2dB | 436Ω | 12Ω | 453Ω | 12.0Ω | 470Ω | 12Ω |
| 3dB | 294Ω | 18Ω | 294Ω | 18.0Ω | 300Ω | 18Ω |
| 5dB | 178Ω | 30Ω | 178Ω | 30.1Ω | 200Ω | 33Ω |
| 6dB | 151Ω | 37Ω | 154Ω | 37.4Ω | 150Ω | 39Ω |
| 10dB | 96Ω | 71Ω | 95.3Ω | 71.5Ω | 100Ω | 75Ω |
| 20dB | 61Ω | 248Ω | 61.9Ω | 249Ω | 62Ω | 270Ω |

The problem with many homebrew step attenuators is the inductance that crops up in the interconnecting wiring and from the leaded components. The inductance, in turn, combines with the stray capacitances to form resonances and notch filters for an erratic response, as the waveforms in the initial tests reveal. The single wide trace used for the through-put line, and the use of surface mount resistors, greatly eliminates the dominant sources of inductance.

The project also shows the extreme importance of maintaining a good RF ground at higher frequencies. Grounding the ground plane at two points, on opposite ends of the board by the SMA connectors, was insufficient. Periodic grounding reduces current loops and maintains a consistent impedance across the board.

Since I used 1206 1/4 W resistors, and a "pi" type attenuator, this implies the maximum power for this attenuator is about 1/2 W. If you want a step attenuator for 5 W QRP levels, it would be best to form your resistances with paralleled resistors to boost the power rather than large 1/2 W or 1 W resistors (with those nasty inductive leads).

Since this project was actually for a noise test set to measure system noise gains and measure atmospheric noise power, it will be used with power levels about –70 dBm to about –10 dBm (the 1 dB compression point of our 74 and 327 MHz receivers and upconverters). Most step attenuators are used at low levels, usually well below 0 dBm (1 mW).

If you decide to try this approach to build a step attenuator, I would like to hear from you to see what results you obtained. Admittedly, if you add more high attenuation (20 dB) switch sections, there will be more leakage problems than I experienced with a 4-switch 40 dB attenuator.

*—72, Paul Harden NA5N*
*na5n@zianet.com*

**The Fine Print . . .**

The Very Large Array (VLA), a world-class premier radio telescope, is operated by the National Radio Astronomy Observatory (NRAO), a facility of the National Science Foundation (NSF) operated under cooperative agreement by Associated Universities, Inc. (AUI). Opinions expressed herein are my own and not necessarily of my employer. No animals were injured in the making of this project. This article is also located on my work website: http://www.aoc.nrao.edu/

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# QRP Contests

Jeff Heatherington—VA3JFF

contest@qrparci.org



As this column goes to print, the summer days finally seem to be upon us in Southern Ontario. School ending for the summer, longer days and bright sunshine undoubtedly call to us to get into the outdoors. We have cars to wash, lawns to mow, and houses that require upkeep. The parks and trails seem to need us to walk along them, the ball fields seem barren without us playing on their grass and the beaches clearly need us to swim, build sand castles and enjoy the sun's rays. We add to that the commitments we all have to our families, whether it is a vacation abroad or teaching our young ones to fly a kite or ride their first two-wheel bicycle. Of course, the Blue Jays seem to be winning more games this summer, too, but that might be more of a distraction only in Southern Ontario.

Summer is a short season, and it is difficult to fit in all of the activities in such a short time. We sometimes need to be creative in ways to work our radio hobby into these other activities. For me, radio takes a back seat in the summer, but doesn't disappear. Our annual vacation will once again see us at Thomas Point Beach in Brunswick, Maine, for the 2009 rendition of Lobstercon. This of course blends radio directly into the family vacation and will allow for some operating time, as well as the usual camaraderie that only QRP seems to enjoy in the world of amateur radio. Other possibilities to sneak in some radio time will be cleaning the eaves troughs, which will allow me to restring my wire antenna, taking the KX1 out onto the trails to operate during breaks from hiking, and reading up on my next antenna projects while watching my family enjoy and play in the outdoors.

Hopefully you may be able to find a way to fit in some time for radio operating, antenna erecting, and of course contesting. Our summer season is filled with the Summer Homebrew Contest in July, the Silent Key Memorial Contest in August and our VHF Contest in it's new time slot in September.

**Mark Your Calendars!**

**Fall QSO Party**
**October 17-18, 2009**

**Top Band Sprint**
**December 3, 2009**

**Holiday Spirits Homebrew Sprint**
**December 20, 2009**

During the past quarter, we only had two contests come to a close. The first contest was the Grid Square Sprint run in March. We replace our usual state or province exchange with our Maidenhead Grid Locator. It makes it a little more interesting as sometimes we start to anticipate the exchange from some of our regular participants. Top spot this year went to Bob Patten, N4BP, with 55,720 points and a leading total of 40 grid squares worked. Second place was Tim Colbert, K3HX, with 12,236 points and 19 grids. Third place finisher, Robert MacKenzie, VA3RKM, took a different approach, using 2 QSOs, in 2 grids, along with a 5,000 point bonus for setting up and operating from a local park in Ottawa to bring in a total of 5,098 points. John T. Laney III, K4BAI, totaled 4,284 points for fourth place, and Larry Maso, NU4B, rounded out the top five with 3,640 points.

The Spring QSO Party saw Willie Baber, WJ9B, claim a total of 1,002,330 points to take top spot away from perennial front runner Bob Patten, N4BP, who took second spot with 844,200 points. Ed Gilliland, W5TM, scored 351,379 points for bragging rights among non-members and a third place finish, just out distancing Vladimir Milutinovic, VE3JM, who finished fourth and was also the top scoring Canadian with 339,675 points. John T. Laney III, K4BAI, had another strong showing taking fifth place with 319,571 points. The Spring QSO Party is also one of our two team competition contests, and returning to top spot this year is the Ontario Contest Club Beaver Boys team of Robert MacKenzie, VA3RKM; Pat Byers, VE3EUR; Vladimir Milutinovic, VE3JM; Art Tolda, VE3UTT; and Richard Ferch, VE3KI. Their total of 715,218 points was enough to hold off the second place Knightlites team of Jean Paul Keon, AA4PP; Randy Hargenrader, K4QO; Dick Haytner, N4HAY; Derek Brown, WF4I; and Joe White, WA4GIR, who all reported having a great time while operating to a total of 305,335 points.

Until next time, keep your power down and your QSO rates up.

*—73/72, Jeff, VA3JFF*

**Grid Square Sprint**
**Top 5 Results**

| | | |
|---|---|---|
| N4BP | 55,720 | Bob Patten |
| K3HX | 12,236 | Tim Colbert |
| VA3RKM | 5,098 | Robert MacKenzie |
| K4BAI | 4,284 | John T. Laney III |
| NU4B | 3,640 | Larry Maso |

**Grid Square Spring Soapbox**

Not many stations on, much QRN on 40m, pretty quiet on 20m. Always great fun.—**K3HX**

Out in an Ottawa Park with a bunch of other hams in the mud and snow. Low score but great fun!—**VA3RKM**

Audio amplifier I built in an Altoids tin boosts the output of my Heathkit Active Filter and makes it easier to pull out the week signals.—**AI2T**

Wanted to start AGCW-QRP-Contest—nobody around, but nice surprise indeed, some US QRP friends!—**HA7UG**

Local noise at my QTH caused me to only work the stronger stations. Many thanks for the fun and sponsorship.—**K8KFJ**

Worked most of the contest, only 7 QSOs. Still had fun—I liked the Grid Square twist.—**WA5RML**

Glad I heard N4BP calling.—**W2JEK**

I worked every station I could hear. Obviously not many were reaching my corner of the USA.—**AD7AN**

Tried to raise something on 40m for

**Grid Square Sprint Results**

| Call | QTH | Score | QSOs | PWR | PTS | Bands | Grids | MULT | Bonus | Rig + Ant |
|---|---|---|---|---|---|---|---|---|---|---|
| N4BP | FL | 55720 | 48 | < 5W | 199 | 20/40 | 40 | 7 | 0 | K3 + Cushcraft A4S, Sewper Armadillo 40/80 dipole |
| K3HX | PA | 12236 | 22 | < 5W | 92 | 20/40 | 19 | 7 | 0 | Orion I + Dipoles |
| VA3RKM | ON | 5098 | 2 | < 5W | 7 | 20 | 2 | 7 | 5000 | K2 + Vertical and Wire |
| K4BAI | GA | 4284 | 12 | < 5W | 51 | 20/40 | 12 | 7 | 0 | FT1000MP + Zepp, Dipole |
| NU4B | TN | 3640 | 11 | < 5W | 52 | 20/40 | 10 | 7 | 0 | K2 + Carolina Windom Short 80 |
| AI2T | NY | 3402 | 12 | < 5W | 54 | 20/40 | 9 | 7 | 0 | K1 + Long wire on 40m, inverted vee on 20m |
| HA7UG | | 1218 | 6 | < 5W | 29 | 20 | 6 | 7 | 0 | FT-920 + 20m 4ele SteppIR |
| K8KFJ | WV | 1050 | 6 | < 5W | 30 | 20/40 | 7 | 5 | 0 | FT817ND + Vertical |
| WA5RML | TX | 966 | 7 | < 5W | 23 | 20 | 6 | 7 | 0 | K2 + 20m vertical |
| W2JEK | NJ | 735 | 5 | < 5W | 21 | 20/40 | 5 | 7 | 0 | FT-840 |
| AD7AN | CA | 616 | 5 | < 5W | 22 | 20/40 | 4 | 7 | 0 | Argonaut V + SteppIR BigIR vertical |
| W5ESE | TX | 560 | 5 | < 5W | 16 | 20 | 5 | 7 | 0 | ATS3 + 100m HOHPL |
| AB8FJ | OH | 140 | 2 | < 5W | 10 | 40 | 2 | 7 | 0 | Argonaut II + End Fed Random Wire |

awhile, but no takers. Heard K7TQ, but he couldn't hear me. Started on 20m with my TT 1320, but had rig blowout, so switched to my AT Sprint 3. The propagation was very poor, with deep QSB.—**W5ESE**

**Spring QSO Party**
**Top 10 Results**

| | | |
|---|---|---|
| WJ9B | 1,002,330 | Willie Baber |
| N4BP | 844,200 | Bob Patten |
| W5TM | 351,379 | Ed Gilliland |
| VE3JM | 339,675 | V. Milutinovic |
| K4BAI | 319,571 | John T. Laney III |
| NG7Z | 242,109 | Paul Beringer |
| W8TM | 213,521 | Paul Kirley |
| VA3RKM | 195,692 | R. MacKenzie |
| K4QO | 179,949 | R. Hargenrader |
| K3HX | 150,696 | Tim Colbert |

**Spring QSO Party Soapbox**

Relaxing contest!—**WJ9B**

This QSO Party reminded me of the stock market—just when you think condx can't get any worse, they do! Seemed like long periods of total blackout on 20m, and never a peep on 15 or 10. Managed to stay in the chari for nineteen hours before giving up in total boredom. Bext DX was an LA8 and a KL7. Worked a few SPs in their contest. On 40m, in addition to storm static, RTTY from their contest extended all the way down to 7030. Maybe we'll get some spots for the Fall Party...—**N4BP**

It was good to have lots of action on a quiet 80m band on Saturday evening. Enjoyed the 2x QRP contact with HA7UG. Thanks, all, for the fun!—**VA3RKM**

The most polite bunch of contesters ever. These contests are always fun!—**K4QO**

Very quiet atmospherics. Some QRM from SP, Missouri contests.—**K3HX**

Great way to spend a snowy weekend. 40m was ruff though.—**KF7MD**

Only around 4 hours as I lent my station to someone for the SPDX Contest.—**VE3UTT**

Lotsa Fun!—**WW3DE**

Participation seemed quite a bit less than last year and conditions were not that good at my QTH.—**KN7T**

Great time! 20m was in fair shape.—**N4HAY**

Main effort on Saturday—family committments on Sunday; Can't wait for the sunspots to pick up, but still a heck of a lot of fun! Thanks to all who copied my signal.—**WA5RML**

I was able to work about six hours of the contest on Saturday, and averaged 10 QSOs per hour. That sure says a lot about the effectiveness of QRP even at the solar minimum. I had a great time and I heard many good ops out there.—**WA6L**

Due to high winds in Arizona static levels made QRP reception a real challenge. Looking forward to next years contest without the wind.—**N7RN**

I finally had a chance to give my somewhat recently completed K1 a good workout. 80M was a true joy on Saturday night. Conditions were good and there was lots of activity. The highlight of the night was working a WP4 through the QRN that developed late. 20M was a bit of a struggle much of the weekend but I was able to work a HA7 easily on Saturday. It is always a thrill to get a 2x QRP DX QSO.—**KD2MX**

I was running K3 on battery power at 5 watts to EFW in the oak trees. Strange weather weekend camped at Knob Noster State Park in Missouri. Everything from nice spring weather to down right chilly, so operated inside the camper. Bands were mixed with 80 meters beat up by nearby Tstorms, 40 was great and 20 was QSB with signals dropping to ESP levels. Repeats were the order of the day for 20. Sometimes it was easier to just read the other ops mind! Modest score with many family distractions, but it was fun to sit at the key when time allowed and make Qs with the crowd. Thanks for the event.—**NØEVH**

Able to be about 12 hours on the air, with lots of nice surprise: AI2T at 250 mW, K8ZFJ at 500 mW, KØRU at 1 W and VE3MGY with 1 W! Less power = more fun! Otherwise several FB sigs, like HP1AC, NU4B and my last one the best KL7IKV—Lynn with 5 W and vertical!—**HA7UG**

Had a very good time, as usual. Participation seemed good and there was decent propagation on the bands considering the SSN has been zero for what seems like forever! It was good to hear so many old friends on the air.—**W2LJ**

Guess I need to operate more. HA7UG was a big surprise!—**K8ZFJ**

The packet and RTTY boys have a new callign frequency 7.030—hvy qrn and other noise.—**KØLWV**

Will sunspots ever return?—**KBØOR**

The best wx we've had for any of our field operations—**WF4I**

Had many things to do during the nice wx weekend but still wanted to op in the contest and was able to get on at the very end.—**WT3S**

Why do all the QRP contestants on 40 congregate on top of each other, within 1 kHz of 7060, rather than spreading out a bit? And, for some reason, the non-contest QROs seem to settle there as well!—**AB2AN**

Great participation and lots of fun. I

## 2009 Spring QSO Party Results

| Call | QTH | Score | QSOs | Power | Pts | Bands | SPC | Mult | Rig & Antenna | Team |
|---|---|---|---|---|---|---|---|---|---|---|
| WJ9B | FL | 1002330 | 332 | < 5W | 1290 | ALL | 111 | 7 | K3, FT1000MP + 15m6, 20m4, 2-40 wires | |
| N4BP | FL | 844200 | 315 | < 5W | 1206 | ALL | 100 | 7 | K3 + A4S, Sewper Armadillo 80/40 dipole | Aluminum Kings |
| W5TM | OK | 351379 | 176 | < 5W | 707 | ALL | 71 | 7 | | |
| VE3JM | ON | 339675 | 160 | < 5W | 647 | ALL | 75 | 7 | FT1000MP Mark V, TS930S + ATB34 4ele, et al. | Beaverboys |
| K4BAI | GA | 319571 | 155 | < 5W | 643 | ALL | 71 | 7 | FT1000MP + Dipole, inv vee, zepp | |
| NG7Z | WA | 242109 | 138 | < 5W | 567 | 20/40 | 61 | 7 | K1 + 7 ele yagi for 20m, 2 ele yagi for 40m | |
| W8TM | OH | 213521 | 128 | < 5W | 517 | ALL | 59 | 7 | K3 + 40m inv vee | |
| VA3RKM | ON | 195692 | | < 5W | 482 | ALL | 58 | 7 | K2 + Verticals and wires | Beaverboys |
| K4QO | SC | 179949 | | < 5W | 451 | ALL | 57 | 7 | Orion + 2 el 20m, 160m loop | Knightlites |
| K3HX | PA | 150696 | 122 | < 5W | 468 | 20/40 | 46 | 7 | K1 + Dipole | |
| KD2JC | NJ | 150696 | | < 5W | 414 | ALL | 52 | 7 | | |
| K8DD | MI | 122120 | 70 | < 1W | 284 | ALL | 43 | 10 | | |
| KF7MD | CO | 122100 | 77 | < 1W | 330 | 20/40 | 37 | 10 | TS680 & HB XCVR + 80m delta loop, vee beam, etc. | |
| VE3UTT | ON | 106596 | 76 | < 5W | 324 | ALL | 47 | 7 | K3 + Optibeam, 80m dipole | Beaverboys |
| WW3DE | DE | 99176 | | < 5W | 322 | Low | 44 | 7 | IC756ProIII + 80m fullwave dipole, et al. | |
| KN7T | WA | 92701 | | < 5W | 323 | ALL | 41 | 7 | K3 + Hexbeam, double bazooka | |
| VE7CA | BC | 87640 | 73 | < 5W | 313 | 20/40 | 40 | 7 | | |
| N4HAY | NC | 76608 | | < 5W | 304 | ALL | 36 | 7 | K2 + TH6DXX, 40m dipole | Knightlites |
| WA5RML | TX | 75621 | | < 5W | 277 | ALL | 39 | 7 | IC703 + G5RV, 20m vertical | |
| VE3KI | ON | 72898 | 60 | < 5W | 254 | ALL | 41 | 7 | K3 + Ground mounted vertical | Beaverboys |
| NT1A | NH | 72891 | 66 | < 5W | 267 | 20/40 | 39 | 7 | | |
| WA6L | CA | 69958 | 64 | < 5W | 263 | ALL | 38 | 7 | K3, MFJ Cub + Log Periodic, Inv L | |
| N7RN | AZ | 64680 | | < 5W | 264 | 20/40 | 35 | 7 | IC756ProIII + Yagi/Windom | |
| NU4B | TN | 61642 | 55 | < 5W | 238 | ALL | 37 | 7 | HW9 + Carolina Windom Short 80 | |
| KD2MX | NJ | 58464 | 59 | < 5W | 232 | ALL | 36 | 7 | K1, FT897 + 350ft longwire | |
| W2JEK | NJ | 54978 | 53 | < 5W | 231 | ALL | 34 | 7 | FT840 | |
| NØEVH | MO | 52675 | 43 | < 5W | 175 | 20/40 | 43 | 7 | K3 | |
| HA7UG | | 52080 | 54 | < 5W | 248 | 20 | 30 | 7 | FT920 + 20m 4ele SteppIR Yagi | |
| WD7Y | NV | 51975 | 54 | < 5W | 225 | 20/40 | 33 | 7 | Orion 2 + Butternut vertical and dipole | |
| K4AXF | VA | 46500 | | < 1W | 186 | 40/80 | 25 | 10 | 40m Rockmite, 80m Rockmite + 1/2 wave doublet | |
| K4CZ | NC | 43645 | 52 | < 5W | 215 | 20/40 | 29 | 7 | TS930 + 2ele yagi, 40m rotatable dipole | |
| W2LJ | NJ | 41650 | 44 | < 5W | 175 | ALL | 34 | 7 | K2 + G5RV | |
| WØUY | KS | 41370 | | < 5W | 197 | ALL | 30 | 7 | K2 + Yagi and Vertical | |
| K8ZFJ | RI | 38500 | 37 | < 1W | 154 | ALL | 25 | 10 | Argo 515, Rockmite 40 + G5RV | |
| K4PBY | FL | 37128 | 51 | < 5W | 221 | 20 | 24 | 7 | Ten-TeC Argonaut + 40m Inv Vee | |
| K9OZ | IL | 36456 | 39 | < 5W | 168 | ALL | 31 | 7 | K3 + 80m dipole, SteppIR Vertical | |
| KØPC | MN | 35868 | 42 | < 5W | 183 | 20/80 | 28 | 7 | | |
| KØLWV | MO | 35448 | 47 | < 5W | 211 | 20/40 | 24 | 7 | IC718 + Longwire vee beam and 20m wire ground plane | |
| KBØR | MN | 34888 | | < 5W | 178 | ALL | 28 | 7 | K3 + HF6V | |
| N2CQ | NJ | 33936 | 53 | < 5W | 202 | 20/40 | 24 | 7 | | |
| HP1AC | | 32508 | 53 | < 5W | 172 | High | 27 | 7 | IC706MkIIG + Rotary Dipole | |
| WF4I | NC | 32074 | | < 5W | 158 | ALL | 29 | 7 | K2 + 80m doublet, Norcal 40m doublet | Knightlites |
| KN1H | NH | 30212 | 38 | < 5W | 166 | ALL | 26 | 7 | FT817 | |
| AA2YV | NY | 27783 | | < 5W | 147 | ALL | 27 | 7 | K1 + 40m Dipole | |
| W3TS | PA | 27600 | 31 | < 1W | 115 | ALL | 24 | 10 | Orion + 160m 1/8 wave tee, 80m and 40m inverted vee, et al. | |
| W9CC | IN | 27552 | | < 5W | | ALL | | | | |
| WA8REI | MI | 27552 | 60 | < 5W | 266 | ALL | 23 | 7 | | |
| N6DIT | CA | 26313 | 43 | < 5W | 179 | 20/40 | 21 | 7 | K3 + G5RV | |
| NØUR | MN | 26208 | 37 | < 5W | 156 | 20/40 | 24 | 7 | | |
| K3MD | PA | 26075 | | < 5W | 149 | ALL | 25 | 7 | Argonaut V + HF6V | |
| KØPIR | SD | 23128 | 32 | < 5W | 118 | 20 | 28 | 7 | TS570D + 2 element Hygain Beam | |
| K4KSR | VA | 20640 | | < 1W | 129 | 80 | 16 | 10 | K1 + Trapped Dipole, Inv L | |
| WF7T | TN | 18942 | 30 | < 5W | 123 | 40 | 22 | 7 | | |
| AB2AN | VA | 16275 | 31 | < 5W | 155 | 40 | 15 | 7 | K1 + Attic Dipole | |
| KJ4IC | NC | 15589 | 34 | < 5W | 131 | 40 | 17 | 7 | FT950 + 4-band ground mount vertical, doublet | |
| W1PID | NH | 14896 | 27 | < 5W | 112 | ALL | 19 | 7 | | |
| WØRSP | AZ | 14847 | | < 5W | 101 | 20/40 | 21 | 7 | KX1 + 40m inv vee | |
| K4DZR | TN | 14276 | | < 5W | | 20/40 | | | | |
| WD9F | IL | 13965 | | < 5W | 105 | 20/40 | 19 | 7 | FT817 + Vertical | |
| KIØJ | CO | 13328 | | < 5W | 112 | ALL | 17 | 7 | Omni 7 + TA33 | |
| WØUFO | MN | 13300 | 23 | < 5W | 100 | 40/80 | 19 | 7 | | |
| WA4GIR | NC | 13104 | | < 5W | 104 | ALL | 18 | 7 | Norcal Sierra + 40m dipole | Knightlites |
| KFØF | MO | 12432 | 24 | < 5W | 111 | ALL | 16 | 7 | K3 + Vertical | |
| WB5FKC | TX | 12000 | | < 250mW | 80 | 40 | 10 | 15 | HB Trx + Inv Vees | |
| N1IMW | NH | 8736 | 19 | < 5W | 78 | ALL | 16 | 7 | | |
| KM3D | PA | 8484 | | < 5W | 101 | ALL | 12 | 7 | IC736 + 80m dipole, cushcraft R8 vertical, Mosley minibeam | |

**2009 Spring QSO Party Results (cont.)**

| Call | QTH | Score | QSOs | Power | Pts | Bands | SPC | Mult | Rig & Antenna | Team |
|---|---|---|---|---|---|---|---|---|---|---|
| NK6A | CA | 7546 | 16 | < 5W | 77 | 20/40 | 14 | 7 | K2 + Force 12C4 | |
| N1LU | NH | 7252 | 16 | < 5W | 74 | ALL | 14 | 7 | | |
| WBØOEW | AZ | 4928 | | < 5W | 64 | 40 | 11 | 7 | K1 + 7ft short vertical | |
| W5USJ | TX | 4900 | | < 5W | 70 | 20 | 10 | 7 | FT817 + 88ft EDZ | |
| VE7GDS | BC | 4872 | 14 | < 5W | 58 | 20 | 12 | 7 | | |
| N6VOH | CA | 4760 | 43 | > 5W | 140 | 20/40 | 34 | 1 | IC703 + CF Zepp | |
| W7TMD | ID | 4312 | 13 | < 5W | 56 | 20/40 | 11 | 7 | | |
| K2MEN | NJ | 4263 | 17 | < 5W | 87 | ALL | 7 | 7 | IC703 + Homebrew Windom | |
| VE6BIR | AB | 4004 | 11 | < 5W | 52 | 20/40 | 11 | 7 | FT817 + Rotatable Dipole on 20m, G5RV for 40m | |
| VE3MGY | ON | 3870 | 10 | < 1W | 43 | 20/40 | 9 | 10 | | |
| AA4PP | NC | 3600 | 9 | < 250mW | 30 | ALL | 8 | 15 | Norcal Sierra + Norcal 40m doublet, 80m doublet | Knightlites |
| K4JPN | GA | 3430 | 11 | < 5W | 49 | 40/80 | 10 | 7 | K2 + 80m CF Zepp | |
| K8KFJ | WV | 2800 | 10 | < 5W | 50 | 80 | 8 | 7 | | |
| W1FA | MA | 2744 | | < 5W | 49 | ALL | 8 | 7 | FT950 + CF Zepp | |
| K4JSI | MD | 2128 | 10 | < 5W | 38 | 20/40 | 8 | 7 | K1 + 30f aluminum foil doublet | |
| VE3GKB | ON | 2107 | 11 | < 5W | 43 | 20/40 | 7 | 7 | | |
| WB2UAQ | NY | 1960 | 11 | < 5W | 40 | Low | 7 | 7 | HW8 + Random wire | |
| WA3GYW | MD | 1904 | 8 | < 5W | 34 | ALL | 8 | 7 | IC718 | |
| XM2AWR | QC | 1519 | 8 | < 5W | 31 | 20/80 | 7 | 7 | | |
| WD9IWP | IL | 1302 | 8 | < 5W | 31 | 20/40 | 6 | 7 | IC735 + 140ft indoor wire dipole | |
| WB8LZG | MI | 1134 | 6 | < 5W | 27 | 40 | 6 | 7 | K2 + 40m Inv L | |
| W5ESE | TX | 1085 | 8 | < 5W | 31 | 40/80 | 5 | 7 | Ten-Tec Omni VI + 100m HOHPL | |
| W2ARP | NJ | 1015 | | < 5W | 29 | 20/40 | 5 | 7 | FT817 + Alpha Delta DXCC | |
| KT9E | IN | 840 | 6 | < 5W | 24 | 20 | 5 | 7 | Oak Hills Explorer 2 + Quarter wave vertical | |
| K4AHK | NC | 420 | 4 | < 5W | 20 | 40 | 3 | 7 | K2 + Buddipole indoors on 4th floor | |
| KJ4WD | NC | 392 | 11 | > 5W | 49 | 40 | 8 | 1 | | |
| VE3EUR | ON | 357 | 4 | < 5W | 17 | 20/40 | 3 | 7 | IC703, NC2030 + Hamsticks | Beaverboys |
| N1NN | MA | 174 | 7 | > 5W | 29 | ALL | 6 | 1 | Ten Tec Pegasus | |
| W6GMT | MN | 168 | 3 | < 5W | 12 | 40 | 2 | 7 | | |
| KD2MU | NY | 140 | 2 | < 5W | 10 | 40 | 2 | 7 | K1 + 135ft dipole | |
| W1FWB | CT | 140 | 2 | < 5W | 10 | | 2 | 7 | HW8 | |
| KF4UCC | | | 8 | | | ALL | | | | |

even got out for a hike and worked CO, GA and Spain from the field. Thanks all for the fun.—**W1PID**

Conditions very poor here and activity seemed very low.—**WØRSP**

My time for operating was limited but enjoyed hearing a lot of friends and working what I could. Will try for more time in the next one.—**WØUFO**

Good weather, good friends, and a chance to make a few contacts as boot! Great weekend!—**WA4GIR**

Can only operate a few hours this time but always great fun!—**WBØOEW**

My first impression on the contest: "These guys are sending at a speed I can work, Woo Hoo!"—**VE7GDS**

Great contest. Glad to hear other folks running QRP. Had fun and looking for the next one.—**N6VOH**

My first QRP contest was pretty rough but I had alot of fun. I can't wait to do it again!—**W7TMD**

Not much of a score, but worked all that I heard.—**VE6BIR**

Had trouble with the rig, found out only putting out 100 mW. I could hear and could never get back to some stations. Had a wonderful time, fantastic weather for the first time in years. We had over 25 guests to the site during the contest and a lot of new prospective hams and new CW ops showed up to see the setup and ask questions.—**AA4PP**

The higher bands were not in very good shape here so I just decided to stick with 80m. I didn't have a lot of time to operate but wanted to put West Virginia out there for those who needed it for a new SPC as I didn't see my State represented in last year's event.—**K8KFJ**

I think conditions were relatively poor on Sunday. Perhaps I'll put in more time in the Fall event. I desparately need a decent 80m antenna.—**K4JSI**

I enjoyed the contest very much. I haven't used my HW8 in many years.—**WB2UAQ**

Very Poor conditions. I worked more stations than I thought!—**WA3GYW**

Been unable to opearte for 10+ years (CC&R) but am working to get the attic wire working better. Good to be back!—**WD9IWP**

Just returned from a backpacking trip to west Texas in time to catch the last couple hours of the contest. Didn't hear anything on 20 meters, but was glad to snatch a few last minute contacts on 40m and 80m.—**W5ESE**

Pictures at http://eastside.indianakits.comspring040409/. Op WD9EYB.—**KT9E**

As a member of the stellar Contest Club of Ontario Beaver Boys I intended to mount a serious effort this time out. Because my home QTH is plagued by almost constant broadband noise at S7-S9 I decided to operate from my mother's place in Gananoque, ON. I set up a vertical using a DK9SQ mast before I realized I had no coax. Arrgh! Just to avoid being shut out I tried operating from the car with Hamstick antennas. Conditions and antennas were poor. In the end I managed only 4 QSOs. Ahh, the best laid plans.—**VE3EUR**

My 1st QRP-ARCI Contest.—**N1NN**

Wanted to try the new K2, but had to resort to the trusty K1; a lot of good that did!—**KD2MU**

I don't work contests, but thought I would just drop in on this one to give a reworked HW-8 a shot.—**W1FWB**

# Contest Announcements

**E-mail Log Submission:**
Submit Logs in plain text format, with a summary stating your Callsign, Entry Category, Actual Power and Station Description, along with score calculation to contest@qrparci.org

**Mail Log Submission:**
Submit Logs with a summary stating your Callsign, Entry Category, Actual Power and Station Description, along with score calculation to:

(Contest Name)
c/o Jeff Hetherington, VA3JFF
139 Elizabeth St. W.
Welland, Ontario
Canada L3C 4M3

**Results:**
Will be published in *QRP Quarterly* and shown on the QRP-ARCI website.

**Certificates:**
Awarded to the top scoring entrant in each category. Certifi-cates may be awarded for 2nd and 3rd place if entries are sufficient in a category. Some contests award certificates to the top scoring operators in each State, Province or Country.

## 2009 QRP-ARCI Fall QSO Party

**Date/Time:**
1200Z on 17 October 2009 through 2400Z on 18 October 2009. You may work a maximum of 24 hours of the 36 hour period.

**Mode:**
HF CW only.

**Exchange:**
Members: RST, State/Province/Country, ARCI member #
Non-Members: RST, State/Province/Country, Power Out

**QSO Points:**
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

**Multiplier:**
SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

**Power Multiplier:**
>5 watts = x1
>1-5 watts = x7
>250 mW - 1 watt = x10
>55 mW - 250 mW = x15
55 mW or less = x20

**Suggested Frequencies:**

| | |
|---|---|
| 160m | 1810 kHz |
| 80m | 3560 kHz |
| 40m | 7030 kHz (please listen at 7040 kHz for rock bound participants) |
| 20m | 14060 kHz |
| 15m | 21060 kHz |
| 10m | 28060 kHz |

**Score:**
Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier.

**Teams:**
You may enter as a team with an unlimited number of operators as long as no more than 5 transmitters are on the air concurrently. You compete individually as well as on the team. Teams need not be in the same location. Team captains must send a list of members to the Contest Manager before the contest.

**Categories:**
Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m)

**How to Participate:**
Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

**Submissions:**
Entries must be postmarked on or before 18 November 2009.

## 2009 QRP-ARCI Top Band Sprint

**Date/Time:**
0000Z to 0600Z on 3 December 2009

**Mode:**
SSB, CW or mixed modes. Work stations once regardless of mode.

**Exchange:**
Members: RS(T), State/Province/Country, ARCI member #
Non-Members: RS(T), State/Province/Country, Power Out

**QSO Points:**
Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

**Multiplier:**
SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

**Power Multiplier:**
(Use the smaller multiplier if operating mixed mode.)
**For SSB QSOs:**
>10 watts = x1
>2 - 10 watts = x7
>500 mW - 2 watts = x10
>100 mW - 500 mW = x15

100 mW or less = x20

**For CW QSOs:**

>5 watts = x1
>1 - 5 watts = x7
>250 mW - 1 watt = x10
>55 mW - 250 mW = x15
55mW or less = x20

**Suggested Frequencies:**

CW: around 1810 kHz
SSB: around 1910 kHz
*Please remember that 1830 to 1835 kHz should be used for intercontinental QSOs only

**Score:**

Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier

**Categories:**

Entry may be SSB, CW or Mixed Mode

**How to Participate:**

Get on top band and hang out near the QRP frequencies listed above. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

**Submissions:**

Entries must be postmarked on or before 3 January 2010.

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## 2009 QRP-ARCI Holiday Spirits Homebrew Sprint

**Date/Time:**

2000Z to 2359Z on 20 December 2009

**Mode:**

HF CW Only.

**Exchange:**

Members: RS(T), State/Province/Country, ARCI member #
Non-Members: RS(T), State/Province/Country, Power Out

**QSO Points:**

Member = 5 points
Non-Member, Different Continent = 4 points
Non-Member, Same Continent = 2 points

**Multiplier:**

SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

**Power Multiplier:**

>5 watts = x1
>1 - 5 watts = x7
>250 mW - 1 watt = x10
>55 mW - 250 mW = x15
55 mW or less = x20

**Suggested Frequencies:**

| | |
|---|---|
| 160m | 1810 kHz |
| 80m | 3560 kHz |
| 40m | 7030 kHz (please listen at 7040 kHz for rock bound participants) |
| 20m | 14060 kHz |
| 15m | 21060 kHz |
| 10m | 28060 kHz |

**Score:**

Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier + Bonus Points.

**Bonus Points:**

If operating a HB Transmitter add 2000 points per band
If operating a HB Receiver add 3000 points per band
If operating a HB Transceiver add 5000 points per band
Homebrew is defined as: "If you built it, it is homebrew" (kits too!)
If you are operating PORTABLE using battery power AND a temporary antenna, add 5000 points to your final score. (You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

**Categories:**

Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m-160m)

**How to Participate:**

Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

**Submissions:**

Entries must be postmarked on or before 20 January 2010.

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**AFTER THE CONTEST . . .**

**All entrants are encouraged to report their claimed scores and share contest "war stories" on QRP-F, the QRP ARCI online forum, at:**

**www.qrparci.org**

## QRP ARCI STAFF

President
**Ken Evans—W4DU**
848 Valbrook Ct.
Lilburn, GA 30047
w4du@bellsouth.net

Vice President
**Kathy Bromley—WQ5T**
3424 Brooken Hill Dr.
Fort Smith, AR 72908
vp@qrparci.org

Treasurer, Membership/Subscriptions
**Jack Nelson—K5FSE**
1540 Stonehaven
Cumming, GA 30040
secretary@qrparci.org

Awards Manager
**Jay Bromley—W5JAY**
3424Brooken Hill Dr.
Fort Smith, AR 72908
jayw5jay@cox.net

Contest Manager
**Jeff Hetherington—VA3JFF**
139 Elizabeth Street West
Welland, ON L3C 4M3, CANADA
contest@qrparci.org

Webmaster
**Steve Fletcher—G4GXL**
43 Philip Rudd Court, Pott Row
Kings Lynn, Norfolk PE32 1WA, UK
webmaster@qrparci.org

## BOARD OF DIRECTORS

**Jay Bromley—W5JAY**
3424Brooken Hill Dr.
Fort Smith, AR 72908
jayw5jay@cox.net

**John Cumming—VE3JC**
154 Guilford Crescent
London, ON N6J 3Y6, CANADA
jbcumming@sympatico.ca

**Hank Kohl—K8DD**
2130 Harrington Rd.,
Attica, MI 48412-9312
k8dd@arrl.net

**Bill Kelsey—N8ET**
3521 Spring Lake Dr.
Findlay, OH 45840
kanga@bright.net

**Ed Hare—W1RFI**
304 George Washington TPKE
Burlington, CT 06013
w1rfi@arrl.org

**Steve Fletcher—G4GXL**
43 Philip Rudd Court, Pott Row
Kings Lynn, Norfolk PE32 1WA, UK
webmaster@qrparci.org

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